Saskatchewan
Environment

Hydrology Branch

1979 Operation of the Qu'Appelle River System

March, 1984
HYD 5-80

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1979

OPERATION OF THE QU'APPELLE RIVER SYSTEM

HYD-5-60

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Chapter I

INTRODUCTION

A. GENERAL

The Qu'Appelle River system stretches across nearly two-thirds of the province, includes nine lakes and is regulated at nine control structures (Figure 1). Its size and complexity offers a unique challenge to its efficient operation. Agricultural, municipal, industrial, recreational and wildlife interests place many and varied demands on both quantity and quality of water in the river system. Therefore, in order to operate the entire system impartially, the Qu'Appelle Operation Board was established. The functions of and appointees to the Board are described in Appendix A.

Originally control structures at the outlets of the Qu'Appelle lakes were built as retaining structures to increase and maintain the storage capacity of the lakes for irrigation and municipal uses. The Craven and Valeport controls were constructed to aid navigation on Last Mountain Lake and the Eyebrow Control was constructed to provide a means of diverting water to the Nisku Waterfowl Project at Eyebrow Lake. Construction of the Gardiner and Qu'Appelle River Dams made it possible to divert water by gravity from the South Saskatchewan River system to augment water supply in the Qu'Appelle.

Today the Qu'Appelle structures are used to improve and maintain domestic and municipal water supply, control river levels when possible to minimize flooding, aid in irrigation, maintain lake levels for recreational purposes and assist in alleviating other concerns such as wildlife habitat needs and fish spawning requirements.

The Qu'Appelle structures have limited effectiveness in controlling extreme floods but are very beneficial in most years. Operations are carried out to achieve the maximum overall benefit to as many users and interest groups as possible. In general all the controls, with the exception of Buffalo Pound Lake control and Qu'Appelle River Dam, are fully opened in fall and left open all winter and most of the spring, allowing the lakes to drain as much as possible thus providing a limited amount of storage and unrestricted flows during spring runoff. Timing and nature of structure operation after spring runoff is related to the magnitude of flows, lake levels, user requirements and weather factors (precipitation and evaporation). The Qu'Appelle River Dam and Buffalo Pound Lake control are operated to provide an adequate water supply in Buffalo Pound Lake for Regina and Moose Jaw municipal water supplies. The Eyebrow control is used in open water season to maintain water levels for the Nisku Project.

More detailed information on these structures and their individual operation is included in Appendix B.

This report summarizes the operation of the Qu'Appelle River system during 1979. Each chapter gives a brief explanation of the circumstances surrounding the operations in a specific reach of the Qu'Appelle River followed by a table giving date, purpose and results of each operation, and another table showing a water balance for the reach.

Flows and lake levels at key locations are presented in graphical form on attached figures. More detailed and precise values can be obtained from data published by Water Survey of Canada.

B. SPRING RUNOFF

Fall and early winter precipitation in the 90 to 115 per cent of normal range indicated that there would be a near normal to slightly above normal spring runoff in the Qu'Appelle basin for 1979. However above normal precipitation in late winter and early spring coupled with a later than normal thaw resulted in a higher than expected runoff.

C. SUMMER RAINSTORMS

A rainstorm in early July, in the Avonlea and upper Moose Jaw River basin area produced significant flows (16 m^3/s) in the Moose Jaw River. Most of this flow was diverted into Last

Mountain Lake by closing the Craven control and opening the Valeport control.

Chapter II

THE UPPER QU'APPELLE

A. GENERAL

Water can be imported from Lake Diefenbaker into the Qu'Appelle River system to meet various water requirements:

- Nisku waterfowl project at Eyebrow Lake;
- Regina and Moose Jaw City water supply from Buffalo Pound Lake;
- Industrial use by Kalium Chemicals Mine at Belle Plaine from Buffalo Pound Lake;
- Fresh water to other downstream lakes during periods of low runoff to augment supply and replace evaporation losses during the summer months;
- maintenance of a live stream for irrigation and stockwatering demands.

The PFRA carries out operations at the Qu'Appelle River Dam (QRD) and Saskatchewan Agriculture operates the Buffalo Pound Lake (BPL) control as requested by Saskatchewan Environment. Saskatchewan Tourism and Renewable Resources operates the control structure and system of controls along the diversion canal at Eyebrow Lake in consultation with Saskatchewan Environment to meet water requirements for the Nisku waterfowl project.

The quantity of water diverted to Eyebrow Lake each year is relatively small and depends on the volume of spring runoff and the amount and timing of precipitation during the summer.

Water is released from the QRD as required during the summer to replace evaporation losses and improve the water quality of Eyebrow Lake.

Natural spring runoff from the upper Qu'Appelle River usually does not supply sufficient inflow to BPL to meet the various demands placed upon it. Of concern at BPL are the water quality requirements for municipal water demands. Therefore, releases from Lake Diefenbaker are often required to maintain a suitable water supply in BPL.

In high runoff years BPL acts as a temporary storage reservoir. Flood waters from the Moose Jaw River may flow into the lake via the control structure at the east end of the lake. Normally the lower quality Moose Jaw River water is prevented from entering the lake, but when flows reach 110 cubic metres per second (m^3/s) in the Moose Jaw River (MJR) the control structure at BPL must be opened to reduce the potential for damage to the structure and dyke at the lower end of the lake.

Water supply for municipal use at Regina and Moose Jaw and

industrial use at the Kalium Chemicals Potash Mine at Belle Plaine account for a fairly steady 1 m^3/s withdrawal from the lake. Evaporation from the lake surface and releases at the stop-log control dam at the east end of the lake account for the remaining losses from storage.

B. 1979 OPERATIONS

Releases of 1.4 m^3/s from the QRD, required to meet water supply demands on BPL, were terminated on February 23 in preparation for spring runoff flows.

Initially inflow to BPL rose to 8.6 m^3/s on March 27. However, with the return of freezing temperatures, flows dropped to near zero in early April. The second melt produced a peak inflow of 18.5 m^3/s on April 20, which quickly fell to 6.5 m^3/s by April 22 and to less then 1 m^3/s by May 3. BPL levels which had receded from a January 1 level of 509.39 metres (m) to a low of 509.14 m, in mid-March just prior to spring runoff, rose to peak at 509.72 m on May 8. Levels remained fairly stable during May then slowly receded to near the upper limit (509.42 m) of the desirable operating range by early July.

Two small releases from the QRD, of 0.7 m^3/s, were made for the periods May 29 to June 5 and June 12 to 19, to supply water to the Nisku project on Eyebrow Lake.

During the July to September period releases from the QRD were periodically increased (July 6 - 0.7 m^3/s; July 25 - 2.1 m^3/s; July 27 - 2.8 m^3/s and August 17 - 3.5 m^3/s) to keep pace with increased demands and higher evaporation losses on BPL. Lake levels receded to 509.4 m in late July, fluctuating near this level until the end of September.

Repairs to the dykes along Eyebrow Lake required the closure of the QRD for the period October 1 to 5. Upon completion of repairs releases were resumed at 3.5 m^3/s to refill the channel, then reduced to 0.7 m^3/s on October 10 to meet demands on BPL. Lake levels remained near 509.4 m for the rest of the year.

The operations of the QRD are outlined in Table 1. During 1979, 40 300 cubic decametres (dam^3) of water was released to the Qu'Appelle River system from Lake Diefenbaker via the QRD. A historical summary of monthly releases from the QRD is shown in Table 2.

Of the total releases from the QRD approximately 1000 dam^3 of water was diverted into Eyebrow Lake. The rest combined with local tributary runoff produced an inflow of 51 400 dam^3 into BPL.

Table 1

1979 QU'APPELLE RIVER DAM OPERATIONS

Period	Operation	Comments
January 1 to May 28	Release of 1.4 m^3/s since October 10, 1978. February 23 - close to zero release.	Release required to meet winter demands on Buffalo Pound Lake (BPL). Release terminated in preparation for spring runoff. BPL levels receded from 509.39 m on January 1 to 509.14 m in mid-March prior to runoff. Peak inflows of 18.5 m^3/s on April 20 raised lake levels to peak at 509.72 m on May 8. By the end of May levels had receded to 509.69 m.
May 29 to September 30	May 29 - open to 0.7 m^3/s June 5 - close June 12 - open to 0.7 m^3/s June 19 - close July 6 - open to 0.7 m^3/s July 25 - increase to 2.1 m^3/s July 27 - increase to 2.8 m^3/s August 17 - increase to 3.5 m^3/s	Two small releases; late May, mid-June, for Nisku project on Eyebrow Lake July to September releses periodically increased to keep pace with increased downstream demands and evapoation loses on BPL. Lake levels recede to 509.4 m in late July and fluctuated near this level until the end of September.
October 1 to December 31	October 1 - close to zero. October 5 - re-establish release of 3.5 m^3/s October 10 - reduce to 0.7 m^3/s	Release terminated to allow repairs to dykes along Eyebrow Lake. Flows resumed to refill the channel then cutback to meet downstream demands on BPL BPL levels remained fairly stable near 509.4 m for remainder of year.

Releases from BPL, of 0.7 m^3/s required to maintain a live downstream flow, were terminated on March 28 in preparation for spring runoff flows.

Flows in the Qu'Appelle River below the MJR peaked at 71 m^3/s on April 26 then receded to 10 m^3/s by the end of June. Heavy rains in the Avonlea and upper MJR areas raised flows in the MJR to 16 m^3/s on July 11 falling to 1 m^3/s in late July and to 0.2 m^3/s by mid-August. Because of the prolonged spring

Table 2

HISTORICAL QU'APPELLE RIVER DAM RELEASES

(Dam^3)

Month/ Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1967	0	0	0	74	54	3 430	12 200	15 500	13 400	15 000	15 300	13 600	88 500
1968	12 600	0	0	0	5 040	11 800	12 000	1 360	74	65	18 400	11 700	73 000
1969	11 800	2,490	0	0	35	47	7 050	4 170	10 700	1 240	6 550	7 540	51 600
1970	4 120	3 340	0	45	75	95	91	91	102	434	7 230	7 140	22 900
1971	4 290	3 080	284	63	623	74	106	1 440	260	3 860	6 660	3 790	24 500
1972	3 790	2 770	455	125	12 500	9 480	16 500	10 600	2 820	1 580	8 740	3 790	73 200
1973	3 790	232	651	14 200	17 000	3 400	14 800	16 000	1 730	5 480	4 380	3 490	85 200
1974	3 320	765	92	125	140	123	531	1 620	110	112	8 960	4 930	20 800
1975	3 790	2 890	91	110	106	1 050	2 500	5 250	5 810	4 270	4 340	4 240	34 400
1976	4 080	934	139	146	321	519	1 330	2 100	7 080	3 750	4 540	4 030	29 000
1977	2 860	2 700	3 060	3 210	9 860	9 940	8 190	9 250	8 710	8 860	3 900	3 280	73 800
1978	3 240	2 280	175	130	1 390	2 310	7 200	10 300	9 760	5 030	3 430	3 550	48 800
1979	3 340	2 850	62	96	291	740	2 870	8 820	9 620	4 600	3 630	3 420	40 300
Mean	4 690	1 870	385	1 410	3 650	3 310	6 570	6 650	5 400	4 180	7 390	5 730	51 200

runoff and summer rains, releases from BPL were not required to maintain a live stream. On September 10 a release of 0.6 m^3/s was made from the BPL control and maintained for the rest of the fall and winter period.

Approximately 13 000 dam^3 of water flowed through the control structure during the year.

A detailed summary of the operations at the BPL control is given in Table 3.

Figure 2 shows QRD releases and operations, flows in the Qu'Appelle River above BPL and BPL levels, outflows and operations.

Table 4 shows a water balance for the year at BPL. The ungauged inflow factor has been introduced to the balance to account for unknown quantities such as the net ground water gain (or loss) and ungauged surface inflow. Miscellaneous uses by the cottage owners, the provincial park, the ski resort, etc., which are not measured but are assumed to be relatively small have also been included in this factor.

Table 3

1979 BUFFALO POUND LAKE CONTROL STRUCTURE OPERATIONS

Period	Operation	Comments
January 1 to August 31	Release of 0.7 m^3/s since November 14, 1978. March 28 - close to zero release.	Release required to maintain live-downstream flow below BPL. Releases were terminated in late March in preparation for spring runoff.
September 1 to December 31	September 10 - open CMP to release 0.6 m^3/s	As MJR levels dropped a release was initiated from BPL to maintain a live downstream for the fall and winter period.

Table 4

1979 WATER BALANCE FOR BUFFALO POUND LAKE

Item	Volume (cubic decametres)	Comments
GAINS		
Gauged Inflow	51 400	Qu'Appelle River above Buffalo Pound Lake.
Precipitation	8 900	Directly on Buffalo Pound Lake. Based on average precipitation recorded at Moose Jaw, Aylesbury, and Dilke meteorological stations (0.31 m).
Ungauged Inflow	7 200	Includes net ground water and ungauged surface inflow.
TOTAL GAINS	67 500	
LOSSES		
Evaporation	23 000	Based on AES large lake evaporation values averaged for Regina and Birsay (0.81 m).
Municipal Uses	27 600	Regina and Moose Jaw water supply.
Industrial Uses	3 800	Kalium Chemicals.
Outflow	13 000	Outflow through the Buffalo Pound Lake control structure.
TOTAL LOSSES	67 400	
Change in Storage	+ 100	+ 0.005 m on Buffalo Pound Lake

Chapter III

LAST MOUNTAIN LAKE - CRAVEN AREA

A. GENERAL

Last Mountain Creek interconnects the Qu'Appelle River and Last Mountain Lake (LML); direction and rate of flow in the creek depends on the relative water levels in the river and lake. During low flow periods, flow in Last Mountain Creek may be controlled by the operation of Valeport and Craven controls. Qu'Appelle River flows may be diverted into LML by closing Craven control and opening Valeport control. Alternately, LML may be lowered by opening both structures. Also, during low flow periods, Craven control is used to regulate downstream flows and maintain upstream water levels to accommodate irrigation uses in the Craven area.

During major floods both Valeport and Craven controls are completely opened. With the structures wide open, the flow conditions in the Valeport-Craven area approximate those which occurred in nature; i.e., before the structures were constructed. At high flows, approximately two thirds of the flow in the Qu'Appelle River enters LML via Last Mountain Creek with the remaining one-third passing downstream of Craven. The structures are left wide open during major floods because: 1) damages from ice and erosion may be reduced and/or prevented;

and 2) any appreciable amount of flow regulation is not possible due to the size of structures and hydraulic characteristics of the valley in the Valeport-Craven area.

Although LML is not on the main stem of the Qu'Appelle River, the fact that water from the Qu'Appelle River can enter the lake makes it extremely important for flood control in the Qu'Appelle Valley. With its large storage capacity, some flood waters can be temporarily stored in the lake thus reducing flooding downstream of Craven. These flood waters can then be released in controlled amounts throughout the summer, without flooding, thus reducing the levels of Last Mountain Lake and also maintaining a live stream throughout the downstream lakes and river.

The PFRA carries out major operations of the Valeport and Craven controls as requested by Saskatchewan Environment, while Saskatchewan Environment operates the screw gates at the Craven control on a day to day basis. This day to day operation is necessary to maintain stable flows downstream and to maintain stable water levels in the Craven market garden area in spite of continually fluctuating upstream flows caused by rain storms in the upper basins, wind effects on LML and BPL releases.

B. 1979 OPERATIONS

Because LML levels were fairly low in the fall of 1978 both the Valeport and Craven controls remained closed (Craven control gates were open to pass upstream flows) for most of the winter in order to prevent further lowering of lake levels.

i) Valeport control - LML levels rose slightly from a January 1 level of 489.62 m to 489.65 m in late March. Logs above the ice level were removed on March 26, then just prior to the arrival of peak flows (April 20-23) all remaining logs were removed in order to divert as much of the runoff as possible into LML. Spring runoff with a peak inflow near 55 m^3/s (60 percent of the 94 m^3/s peak flow at Lumsden) resulted in a inflow of 132 000 dam^3 into LML. This inflow from the Qu'Appelle plus an additional 55 000 dam^3 via various minor tributaries raised LML levels to peak at 490.55 m on May 29.

As levels began to recede the structure was closed on June 11. Because of a rainstorm in the upper MJR basin, which produced flows of 16.5 m^3/s (July 13) at Lumsden, two bays of the control were opened (Craven closed at the same time) on July 11 to 13 to divert flows into LML and lessen the threat of downstream flooding. After this brief period of inflow, the bays were left open allowing

an outflow of approximately 2 m^3/s (controlled via Craven control), which combined with evaporation losses lowered LML to 490.08 m by the end of September. On October 1 all the logs were removed to drawdown the lake in preparation for the 1980 runoff. Lake levels fell to 489.68 m by the end of December.

A detailed summary of the operation of the Valeport control is given in Table 5.

Table 5

1979 VALEPORT CONTROL STRUCTURE OPERATIONS

Period	Operation	Comments
January 1 to March 25	Two centre bays logged to 490.0 m all other bays at 490.4 m since mid-1978.	Last Mountain Lake (LML) levels in middle of operating range in fall of 1978 therefore no major drawdown operations required. Lake levels rose slightly from 489.62 m on January 1 to 489.66 m in late March.
March 26 to July 10	March 26 to 28 - remove logs to 489.6 m in all bays. April 20 to 23 - remove all remaining logs. June 4 to 11 - log all bays to 490.5 m. June 26 - tighten logs.	Logs above ice level (489.6 m) were removed in late March in preparation for spring run-off. Just prior to arrival of peak flows the structure was opened to divert as much of the runoff as possible into LML. Peak inflows of 55 m^3/s raised lake levels to peak at 490.55 m on May 29. When flows begin coming out of lake the structure was closed, logs are tightened in late June to reduce leakage. Lake levels recede to 490.45 by the end of June.
July 11 to September 30	July 11 to 13 - remove all logs from two centre bay.	Heavy rains in the MJR Basin produced flows of 16.5 m^3/s at Lumsden neccesitating opening the control and diverting flows into LML; to prevent downstream flooding. (Craven control also closed in conjunction with this operation). After this brief period of inflow, the bays were left open allowing approximately 2 m^3/s outflow from LML resulting in a lowering of the lake to 490.08 m by the end of September.
October to December 31	October 1 and 2 - remove all logs, structure wide open.	In early October all logs were removed to drawdown the lake in preparation for the 1980 spring runoff. Lake levels fell to 489.86 m by the end of December.

ii) Craven control - Flows past Craven fluctuated in the 1 to 1.5 m^3/s range from January 1 until late March. Just prior to spring runoff (March 26-28) all logs were removed from the control. Spring runoff flows peaked at 38 m^3/s on April 28 (40 percent of Lumsden peak), receding to 15 m^3/s in early June and to near 2 m^3/s in early July. Flows past Craven, from a rainstorm in the upper MJR basin, peaked at 10.5 m^3/s on July 11 at which time the control was logged to 490.7 m and the gates were closed, reducing flows to the 1.5 m^3/s range. This operation was done in conjunction with the opening of the Valeport control to lessen the threat of downstream flooding. As these flows receded the Craven control was opened and periodically adjusted to maintain a flow of 3 to 3.5 m^3/s for the summer period. During October the structure was gradually opened. Flows peaked at 8 m^3/s in mid-October slowly receding to 3 m^3/s by the end of the year. During the year 208 000 dam^3 flowed past the Craven control.

A detailed summary of the operation of the Craven control is given in Table 6.

Table 6

1979 CRAVEN CONTROL STRUCTURE OPERATIONS

Period	Operation	Comments
January 1 to July 10	Both gates wide open, bays logged at 490.6 m since November 14, 1978. March 26 to 28 remove all logs structure wide open. June ?? unauthorized installation of some logs.	Gates open to pass upstream flows. Flows of 1.5 m^3/s in early January dipped to 0.9 m^3/s in mid-January then rose to 1.5 m^3/s where it remained until late March prior to spring runoff. Logs were removed to allow for a natural split of spring runoff. Flows peaked at 38.3 m^3/s on April 28, receding slowly to 15 m^3/s in early June and to 2 m^3/s in early July.
July 11 to September 30	July 11 to 13 - close gates and log all bays to 490.7 m. July 16, 17, 29, August 31 and September 26 open and adjust gates to maintain flows in 3 to 3.5 m^3/s range.	Rains in the MJR necessitated closing Craven (at same time opening Valeport control) to lessen the threat of downstream flooding. Flows peaked at 10.5 m^3/s dropped to 1.5 m^3/s with closure of control. As high flows receded the Craven control was opened and adjusted to maintain a flow of 3 to 3.5 m^3/s for remainder of the summer.
October 1 to December 31	October 1 to 3 remove logs to 489.6 m. October 9 remove 8 logs. October 15 remove 8 logs. October 31 remove all remaining logs.	During October the structure was gradually opened. Flows peaked at 8 m^3/s in mid-October slowly receding to 3 m^3/s at year end.

Table 7 shows a water balance for the LML and Valeport-Craven area for 1979. The ungauged inflow factor has been introduced to the balance to account for unknown quantities such as the net ground water gain (or loss) and ungauged surface inflow. Miscellaneous uses by cottage owners, provincial and regional parks, and market garden irrigation which are not measured and are assumed to be relatively small have also been included in this factor.

Figure 3 shows the main tributary flows between BPL and Lumsden and flows in the Qu'Appelle River near Lumsden. Valeport operations, Last Mountain Lake inflows, outflows (via the Qu'Appelle) and levels and flows in the Qu'Appelle River below Craven Dam are shown on Figure 4.

Table 7

1979 WATER BALANCE FOR LAST MOUNTAIN LAKE AND VALEPORT-CRAVEN AREA

Item	Volume (cubic decametres)	Comments
GAINS		
Gauged Inflow	252 000	Qu'Appelle River at Lumsden.
	7 260	Boggy Creek.
	19 700	Arm River.
	2 440	Lewis Creek.
	25 400	Lanigan Creek.
Precipitation	56 700	Directly on Last Mountain Lake. Based on average precipitation recorded at Dilke, Last Mountain Lake, Lumsden, Watrous and Nokomis meteorological stations (0.28 m).
Ungauged Inflow	+ 52 100	Includes net ground water and ungauged surface inflow.
TOTAL GAINS	415 600	
LOSSES		
Gauged Outflow	208 000	Qu'Appelle River below Craven.
Evaporation	158 000	Based on AES large lake evaporation values averaged for Regina and Wynyard (0.78 m).
TOTAL LOSSES	366 000	
Change in Storage	+ 49 600	+ 0.245 m on Last Mountain Lake

Chapter IV

THE FISHING LAKES

A. GENERAL

This area includes Pasqua, Echo, Mission and Katepwa Lakes, collectively known as the Fishing Lakes. An operable control structure exists at Echo Lake, while a fixed weir structure plus a newly constructed (1978-79) operable control is in place at Katepwa Lake. Operations carried out at the control structures of these lakes are mainly to control the levels of the lakes and provide minimum downstream flows; the nature of the structures and the characteristics of the lakes and the conveyance channel limit their value in terms of flood control.

The PFRA is responsible for carrying out operations at the Echo Lake Control while Saskatchewan Agriculture operates the new Katepwa Lake contol as requested by Saskatchewan Environment.

B. 1979 OPERATIONS

Even though the Echo control was wide open, inflows averaging 1.2 m^3/s raised Echo Lake levels from a January 1 level of 478.46 m to 478.60 m in mid-April prior to runoff. Peak

inflows of 38.5 m^3/s (May 3) raised Echo Lake levels to peak at 479.46 m on May 14. By mid-June levels had receded into the operating range and the structure was logged to 478.9 m. As levels continued to drop, another row of logs was added to the structure in early July. Even with an inflow of 3 to 3.5 m^3/s evaporation losses and a small outflow lowered lake levels to 478.95 m by the end of September. On August 30 all the logs were removed and a mat of algae that had built up against the structure was washed downstream, after which the control was relogged to its former elevation. During October all the logs were gradually removed to lower lake levels in preparation for the 1980 spring runoff. Lake levels receded to 478.57 m by the year end. A detailed summary of the operation of the Echo Lake control is given in Table 8.

Table 8

1979 ECHO LAKE CONTROL STRUCTURE OPERATIONS

Period	Operation	Comments
January 1 to September 30	Wide open since October 30 1978. June 13 - log all bays to 478.9 m. July 3 to 6 - log to 479.0 m. August 30 - remove all logs; flush algae downstream, relog to 479.0 m.	In spite of a wide open control, inflows averaging 1.2 m^3/s raised Echo Lake levels from a January 1 level of 478.46 m to 478.60 m in mid-April, prior to runoff. Peak inflows of 38.5 m^3/s on May 3 raised Echo Lake levels to peak at 479.46 m on May 14. As levels dropped into the operating range, mid-June, the structure was partially closed to lessen further lowering of the lake. Levels slowly receded to 478.95 m by the end of September.
October 1 to December 31	October 1 - remove 3 logs from each bay. October 18 - remove 1 log from each bay. November 8 - remove all remaining logs.	To lower lake levels in preparation for 1980 spring runoff the structure was gradually opened during October and early November. Lake levels receded to 478.57 m by year end.

The new Katepwa control was not operated in 1979.

During the year gauged inflow and outflow to the Fishing Lakes balanced at 225 000 dam^3. Ungauged inflow was partically offset by net evaporation resulting a slight increase in lake storage of 2 800 dam^3 (+0.11 m on Pasqua-Echo Lakes and -0.023 m on Mission-Katepwa Lakes). During the fall draw down period outflow from Katepwa Lake rose from late summer flows of 1 to 1.5 m^3/s to peak at an estimated 10 m^3/s in mid-November receding to the 4 m^3/s range at the end of December.

Table 9 gives a water balance for the Fishing Lakes during 1979. The ungauged inflow factor has been introduced to the balance to account for unknown gain (or loss) and ungauged surface inflow. Miscellaneous uses by cottage owners, provincial parks and the Fish Hatchery which are not measured and are assumed to be relatively small have also included in this factor.

Figure 5 shows the hydrographs of the Qu'Appelle River below Loon Creek (inflow to Fishing Lakes), Echo Lake levels and operations, and Katepwa Lake levels and outflow.

Table 9

1979 WATER BALANCE FOR THE FISHING LAKES

Item	Volume (cubic decametres)	Comments
GAINS		
Gauged Inflow	204 000	Qu'Appelle River below Loon Creek.
	4 600	Jumping Deer Creek.
	16 400	Echo Creek.
Precipitation	10 000 (Pasqua-Echo)	Directly on all Fishing Lakes. Based on the average precipitation recorded at Cupar, Balcarres, Indian Head, and Qu'Appelle meteorological stations (0.33 m).
	7 600 (Mission-Katepwa)	
Ungauged Inflow	+ 19 400	Includes net ground water, ungauged surface inflow.
TOTAL GAINS	262 000	
LOSSES		
Gauged Outflow	225 000	Qu'Appelle River at outlet of Katepwa Lake.
Evaporation	19 400 (Pasqua-Echo)	Based on AES large lake evaporation value for Indian Head (0.64 m).
	14 800 (Mission-Katepwa)	
TOTAL LOSSES	259 200	
Change in Storage	+ 3 340	+ 0.11 m on Pasqua and Echo Lakes and
	- 540	- 0.023 m on Mission and Katepwa Lakes
	+ 2 800	

Chapter V

THE LOWER QU'APPELLE

A. GENERAL

This area reaches from Katepwa Lake to the Manitoba boundary including Crooked and Round Lakes. Operable control structures exist at Crooked and Round Lakes. Operations carried out at the control structures of these lakes are mainly to control the levels of the lakes and maintain downstream flows; the nature of the structures and the characteristics of the lakes and the conveyance channel limit their value in terms of flood control.

The PFRA is responsible for carrying out all operations at these controls as requested by Saskatchewan Environment.

B. 1979 OPERATIONS

i) Crooked Lake - Although the structure was wide open lake levels rose slightly from a January 1 level of 450.93 m to 450.98 m in mid-March prior to spring runoff. Peak inflows of 152 m^3/s on April 23 raised lake levels to peak at 453.07 m on April 27. By mid-June levels had dropped into the operating range (451.7 m) and the structure was logged to 451.4 m. In early July levels

reached the middle of the operating range (451.55 m) and another row of logs was installed. Lake levels rebounded to 451.65 m in mid-July slowly receding to 451.23 m by the end of September. Throughout October logs were removed in stages to lower lake levels in preparation for the 1980 spring runoff. Lake levels fell to 450.95 m by November 12. With the arrival of flows (peak of 10 m^3/s) from the drawdown releases from upstream lakes, levels rose slightly to 451.06 m then slowly receded to 450.97 m by the end of December.

A detailed summary of operations for the Crooked Lake control is given in Table 10.

Table 10
1979 CROOKED LAKE CONTROL STRUCTURE OPERATIONS

Period	Operation	Comments
January 1 to May 31	Wide open since October 31 1978.	Lake levels rose slowly from a January 1 level of 450.93 m to 450.98 m in mid-March prior to runoff. Peak inflows of 152 m^3/s on April 23, raised lake levels to peak at 453.07 m on April 27. Levels fell to 451.97 m by the end of May.
June 1 to September 30.	June 21 - log all bays to 451.4 m. July 3 to 6 - build up logs to 451.5 m.	When levels dropped into the operating range, mid-June, the structure was partially closed. As lake levels continued to drop more logs were installed. Lake levels reached a low of 451.55 m on July 5 then rebounded to 451.65 m following structure closure, then slowly receding to 451.23 m at the end of September.
October 1 to December 31	October 10 - remove logs to establish 1 log depth of flow in all bays. October 18 - remove 1 log from each bay. October 31 - remove all remaining logs.	To lower lake levels in preparation for 1980 spring runoff the structure was opened during October. Lake levels dropped to 450.95 by November 12, then as upstream flows of 10 m^3/s (from downstream of upstream lakes) reached the lake, levels rose to 451.06 m then receded to 450.97 m at year end.

ii) Round Lake - With a wide open control lake levels rose from a January 1 level of 441.47 m to 441.55 m in mid-February, receding to 441.51 m in mid-April prior to runoff. From a peak level of 443.71 m on May 1 peak outflows in the 60 m^3/s rapidly lowered levels to 442.76 m by the end of May. By mid-June levels had reached the upper limit (442.42 m) of the operating range and the structure was logged to 442.0 m. In early July logs were installed to 442.2 m as levels reached the middle of the operating range (442.25 m). Levels remained stable until early August then dropped to 441.91 m by the end of September. Throughout October logs were removed in stages in preparation for the 1980 spring runoff. Lake levels receded to 441.71 m in mid-November rising to 441.78 m by December 20 with the arrival of upstream flows receding to 441.74 m at years end. Late summer flows in the 2 to 3 m^3/s range rose gradually during the drawdown period peaking at 7.5 m^3/s in late December falling to 6.5 m^3/s at year end.

A detailed summary of operations for the Round Lake structure is given in Table 11.

Table 11

1979 ROUND LAKE CONTROL STRUCTURE OPERATIONS

Period	Operation	Comments
January 1 to May 31	Wide open since October 31 1978.	Lake levels rose from 441.47 m January 1 to 441.55 m in mid-February and receded to 441.51 m in mid-April prior to runoff. Peak inflows raised lake levels to peak at 443.71 m on May 1. Outflows near 60 m^3/s lowered lake levels to 442.76 m by the end of May.
June 1 to September 30.	June 21 - log all bays to 442.0 m. July 3 to 6 - build up logs to 442.2 m.	When levels had dropped into the operating range, mid-June, the stucture was partially closed in two stages. Levels fell to the middle of the range by early July, remained stable until early August then dropped to 441.91 m by the end of September. Outflows of 35 m^3/s in early June fell to 15 m^3/s in early July and to 5 m^3/s following closure of the structure, receding throughout the summer.
October 1 to December 31	October 10 - remove logs to establish 1 log depth of flow in all bays. October 18 - remove 1 log from each bay. October 31 - remove all remaining logs.	To lower lake levels in preparation for the 1980 spring runoff the structure was opened during October. Lake levels fell to 441.71 m in mid-November recovering to 441.78 m as upstream flows reached the lake, receding to 441.74 m at year end. Outflows peaked at 7.5 m^3/s during drawdown.

During the year gauged inflows of 326 000 dam^3 plus ungauged inflows of 47 700 dam^3 minus a gauged outflow of 361 000 and a net evaporation of 9 500 dam^3 resulted in a slight net gain of 3 000 dam^3 in lake storage (0.04 m on Crooked Lake and 0.27 m on Round Lake).

A water balance for the Lower Qu'Appelle is given in Table 12. The ungauged inflow factor has been introduced to the balance to account for unknown quantities such as net ground water gain (or loss) an ungauged surface inflow (from the many ungauged tributaries in this reach - Kaposvar, Pearl,

Bearhead, Scissors, Squawhead, etc.). Miscellaneous uses by cottage owners, provincial parks, and numerous agricultural irrigation projects which are not measured and are assumed to be relatively small have also included in this factor.

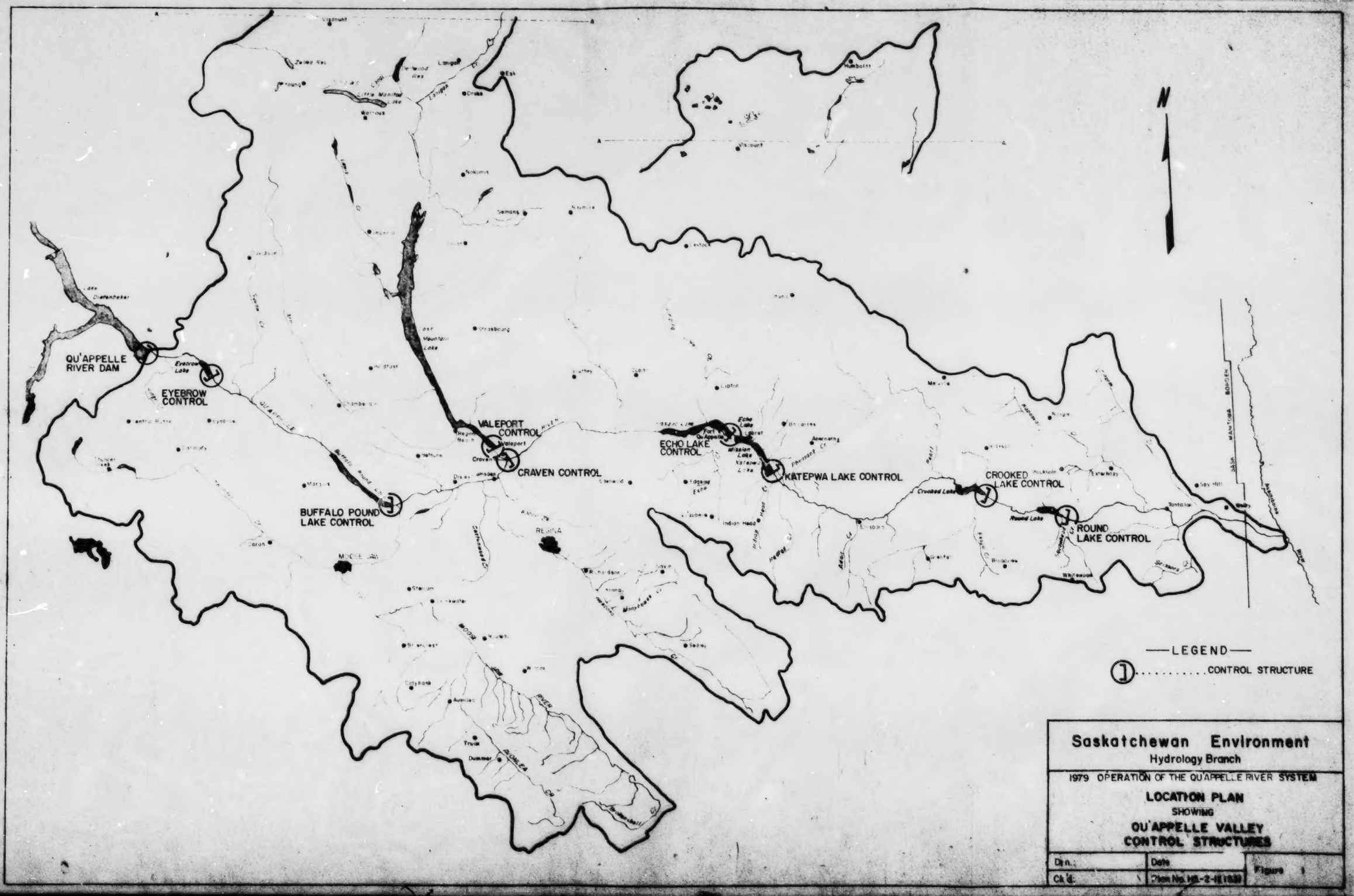
Figure 6 shows the hydrographs of the Qu'Appelle River at Hyde (inflow to the area), Crooked and Round Lake levels and operations, and the Qu'Appelle River at Welby (outflow from the area).

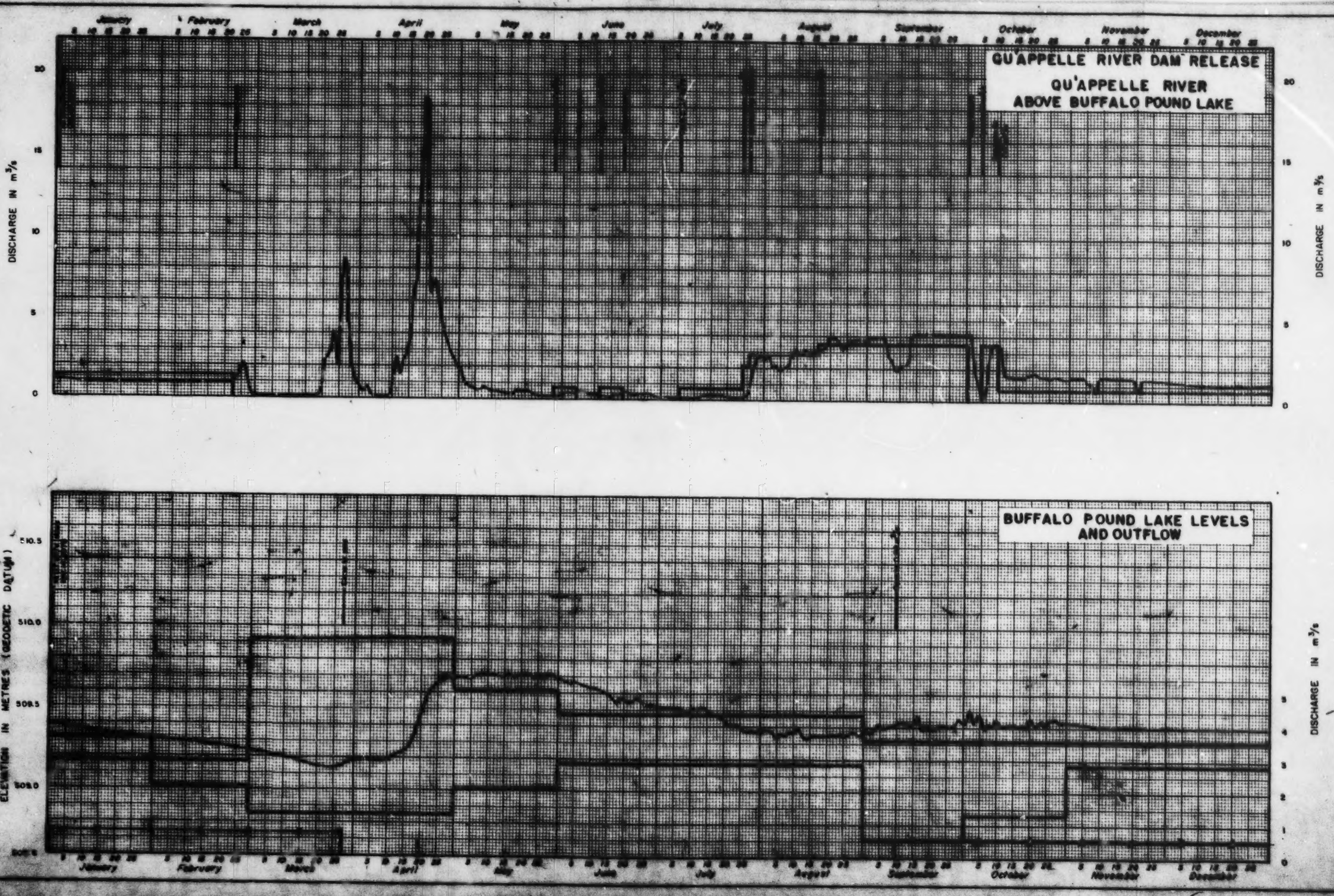
Table 12

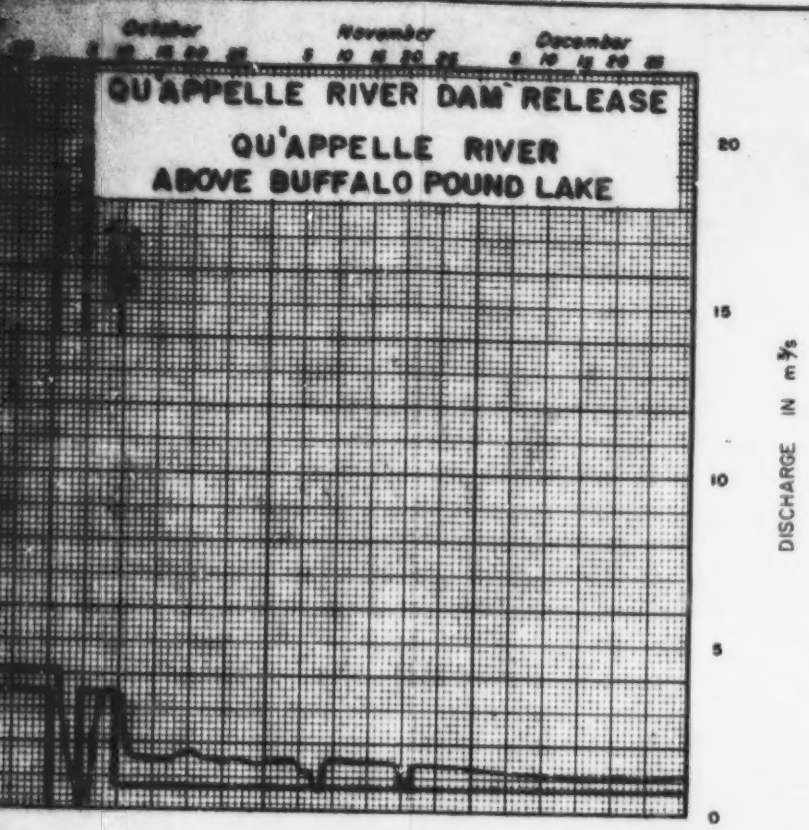
1979 WATER BALANCE FOR THE LOWER QU'APPELLE

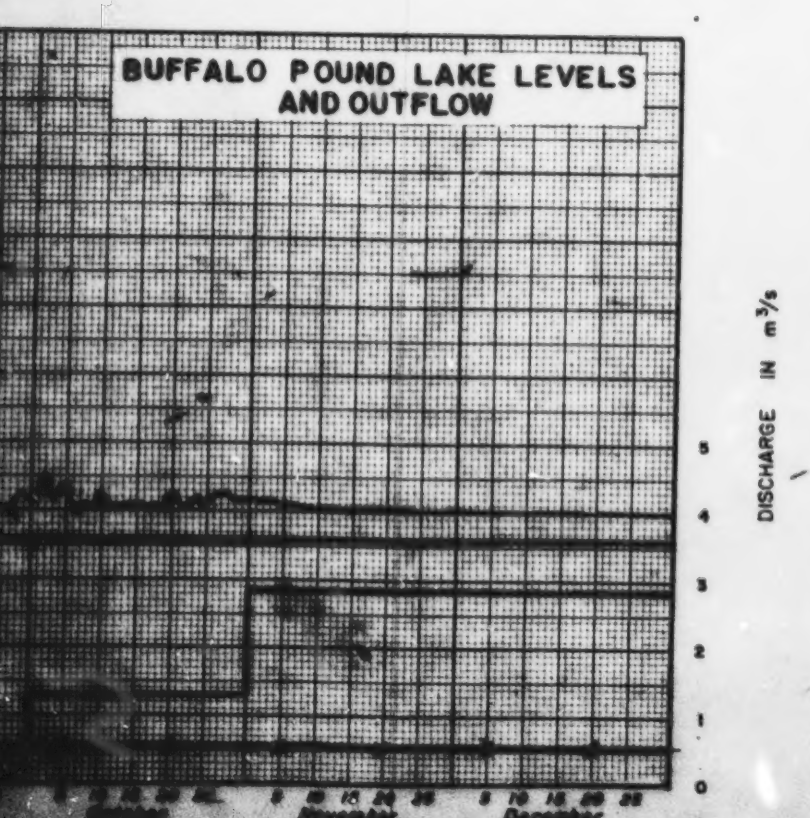
Item	Volume (cubic decametres)	Comments
GAINS		
Gauged Inflow	290 000	Qu'Appelle River at Hyde.
	23 000	Ekapo Creek.
	12 600	Cutarm Creek.
Precipitation	4 460 (Crooked Lake)	Directly on Crooked and Round Lakes. Based on average precipitation recorded at Broadview, Whitewood and Melville meteorological stations (0.29 m).
	2 470 (Round Lake)	
Ungauged Inflow	+ 47 300	Includes net ground water and ungauged surface inflow.
TOTAL GAINS	379 800	
LOSSES		
Gauged Outflow	361 000	Qu'Appelle at Welby.
Evaporation	10 600 (Crooked Lake)	Based on AES large evaporation values averaged for Broadview and Yorkton (0.69 m).
	5 870 (Round Lake)	
TOTAL LOSSES	377 500	
Change in Storage	+ 700	+ .043 m on Crooked Lake and + 0.195 m on Round Lake.
	+ 1 600	
	+ 2 300	

FIGURES


QU'APPELLE RIVER DAM
EYEBROW CONTROL
VALEPORT CONTROL
CRAVEN CONTROL
BUFFALO POUND LAKE CONTROL
ECHO LAKE CONTROL
KATEPWA LAKE CONTROL
CROOKED LAKE CONTROL
ROUND LAKE CONTROL
REGINA
MOOSE JAW
N
LEGEND
CONTROL STRUCTURE
Saskatchewan Environment
Hydrology Branch
1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM
LOCATION PLAN
SHOWING
QU'APPELLE VALLEY
CONTROL STRUCTURES
Dm.
Date
Ck'd:
Plan No. HR-2-16(1979)
Figure 1


QU'APPELLE RIVER DAM RELEASE
QU'APPELLE RIVER
ABOVE BUFFALO POUND LAKE
DISCHARGE IN m³/s
January
February
March
April
May
June
July
August
September
October
November
December
BUFFALO POUND LAKE LEVELS
AND OUTFLOW
ELEVATION IN METRES (GEODETIC DATUM)
510.5
510.0
509.5
509.0
DISCHARGE IN m³/s





LEGEND

- QU'APPELLE RIVER DAM RELEASE
- QU'APPELLE RIVER ABOVE BUFFALO POUND LAKE
- BUFFALO POUND LAKE LEVEL
- BUFFALO POUND LAKE OUTFLOW (INFLOW SHADED)
- MAXIMUM AND MINIMUM DESIRABLE LAKE LEVELS

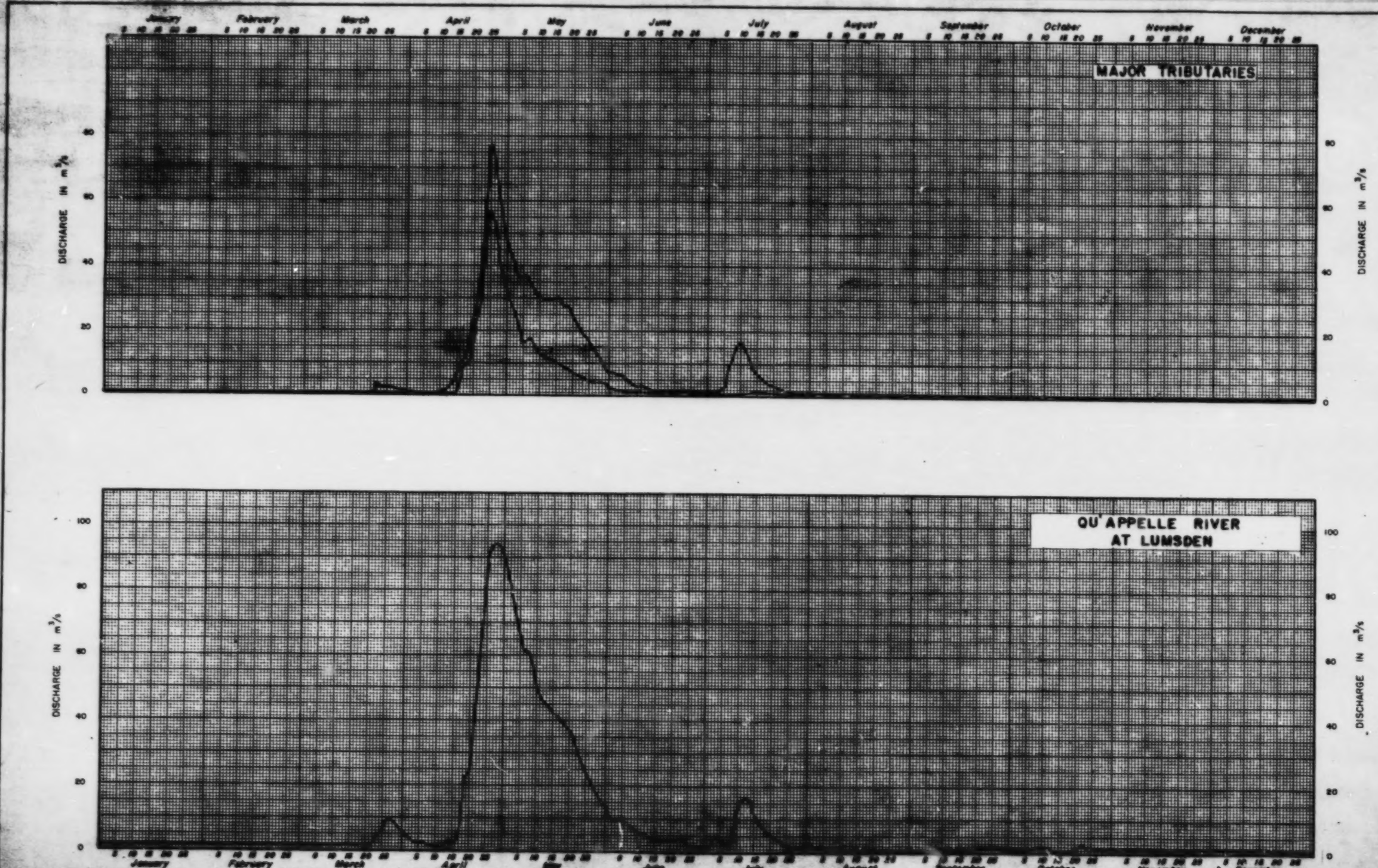
NOTE PROVISIONAL DATA ONLY

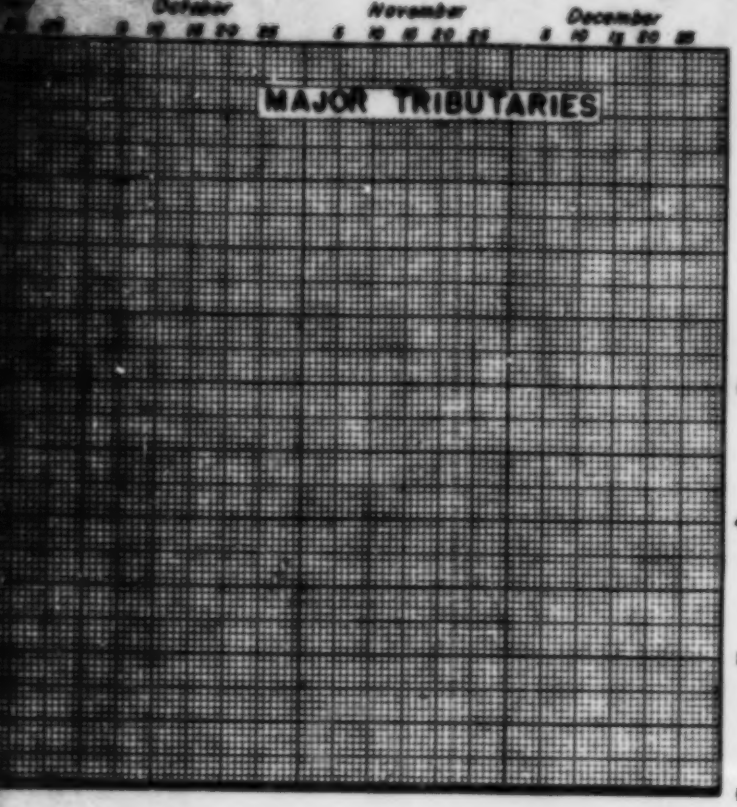
Saskatchewan Environment
Hydrology Branch

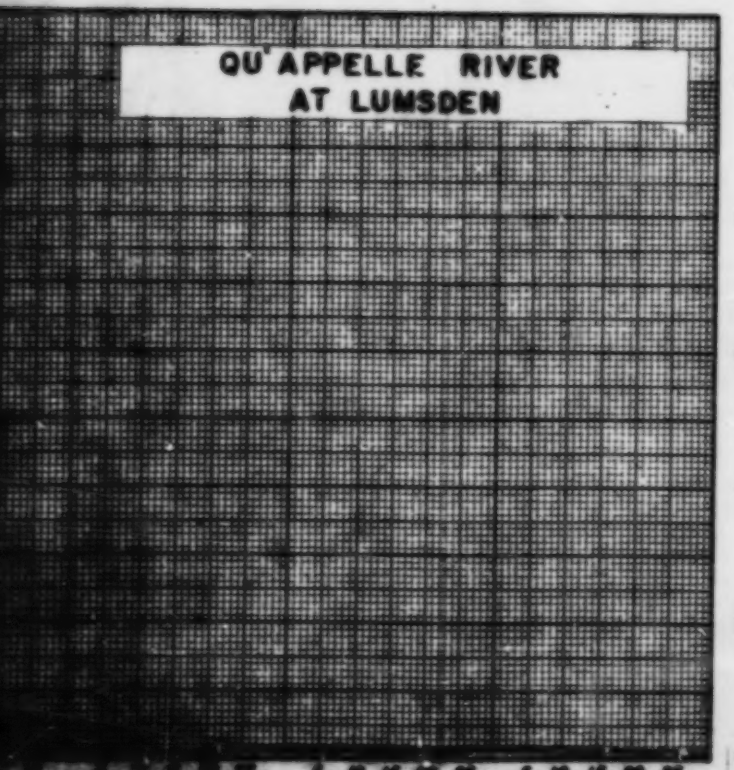
1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM

UPPER QU'APPELLE

Drn.: G.S.Y.	Date: JANUARY, 1981	Figure 2
Ck'd:	Plan No. HS-2-K(154)	


January
February
March
April
May
June
July
August
September
October
November
December
MAJOR TRIBUTARIES
DISCHARGE IN m³/s
0
20
40
60
80
100
QU'APPELLE RIVER
AT LUMSDEN





LEGEND

- MOOSE JAW RIVER NEAR BURDICK
- WASCANA CREEK NEAR LUMSDEN
- QU'APPELLE RIVER NEAR LUMSDEN

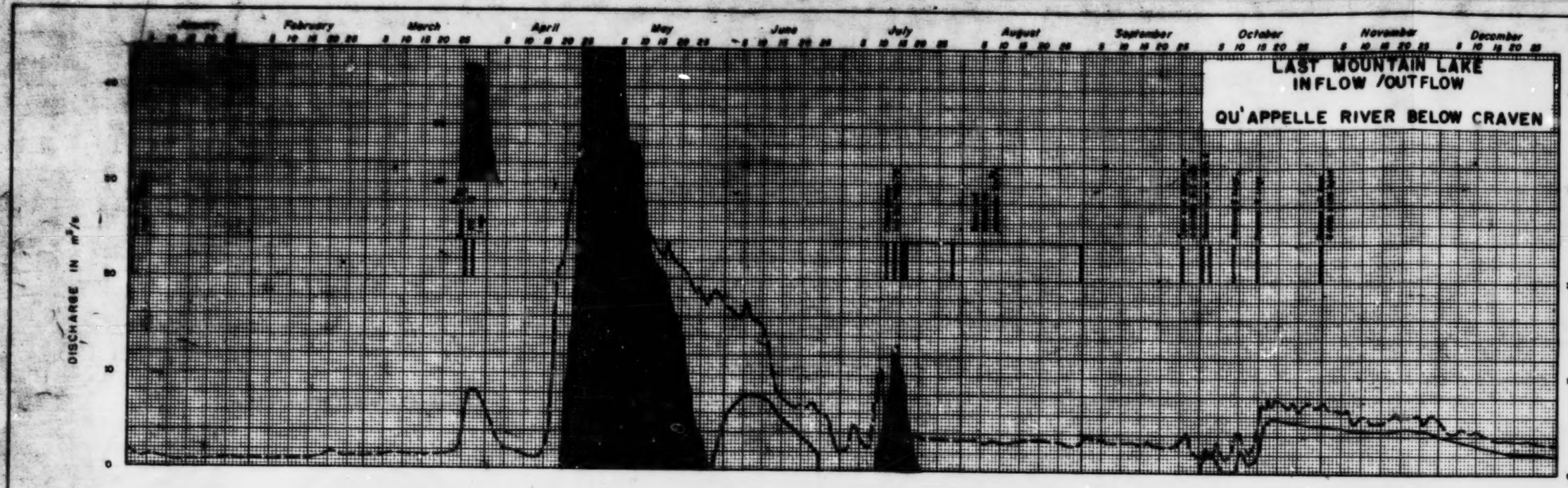
NOTE PROVISIONAL DATA ONLY

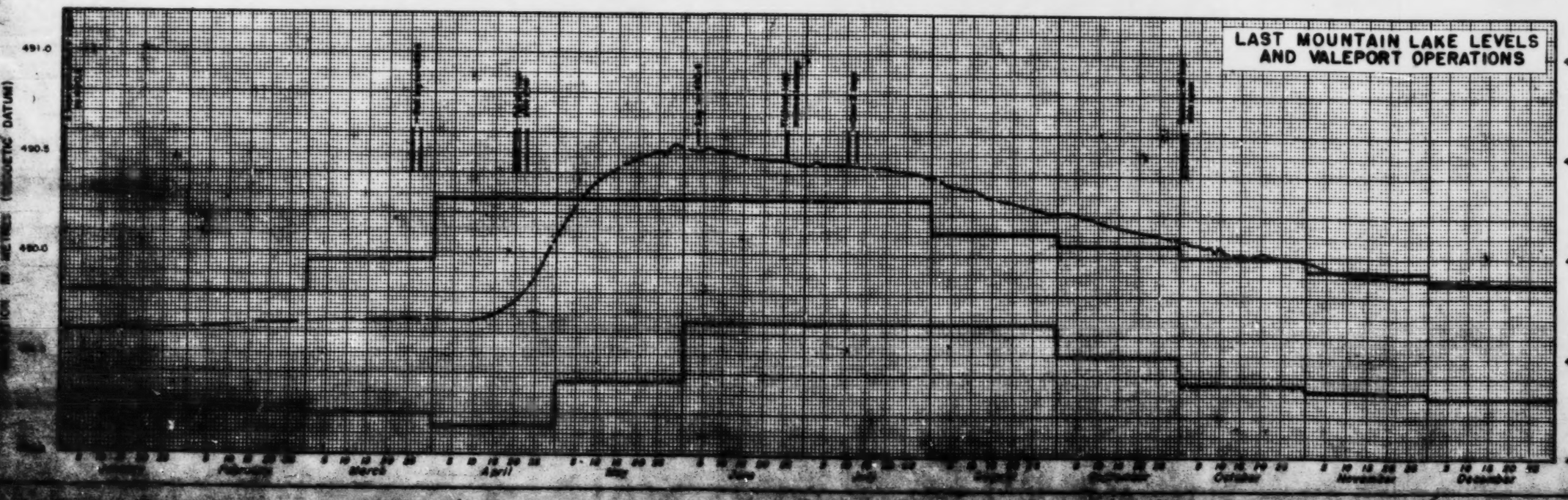
Saskatchewan Environment
Hydrology Branch

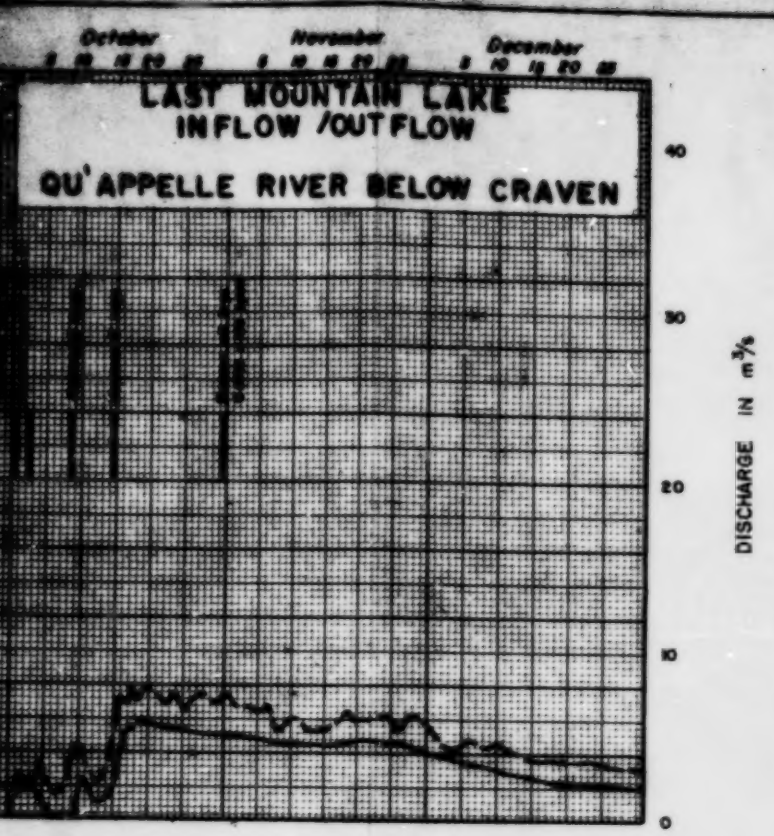
1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM

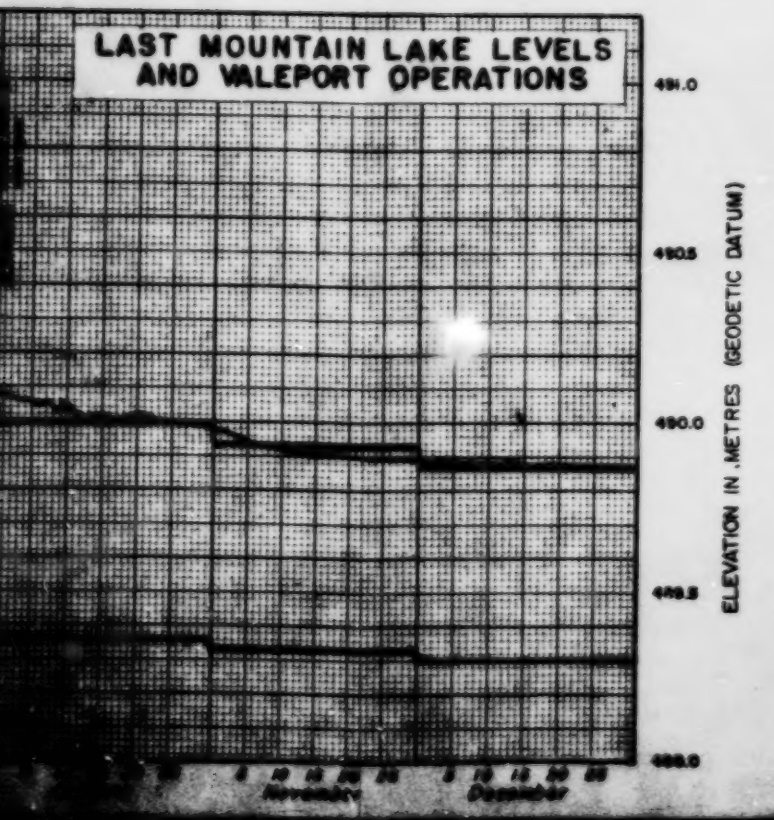
LUMSDEN AREA

Drn.: G.S.Y.	Date: JANUARY, 1981	Figure 3
Ckd.:	Plan No. H5-2-II(155)	


LAST MOUNTAIN LAKE
INFLOW /OUTFLOW
QU'APPELLE RIVER BELOW CRAVEN
DISCHARGE IN m³/s
January
February
March
April
May
June
July
August
September
October
November
December


LAST MOUNTAIN LAKE LEVELS
AND VALEPORT OPERATIONS
ELEVATION IN METRES (GEODETIC DATUM)
491.0
490.5
490.0
489.5
489.0





LEGEND

- LAST MOUNTAIN LAKE INFLOW/OUTFLOW (INFLOW SHADED)
- QU'APPELLE RIVER BELOW CRAVEN
- LAST MOUNTAIN LAKE LEVEL
- MAXIMUM AND MINIMUM DESIRABLE LAKE LEVELS

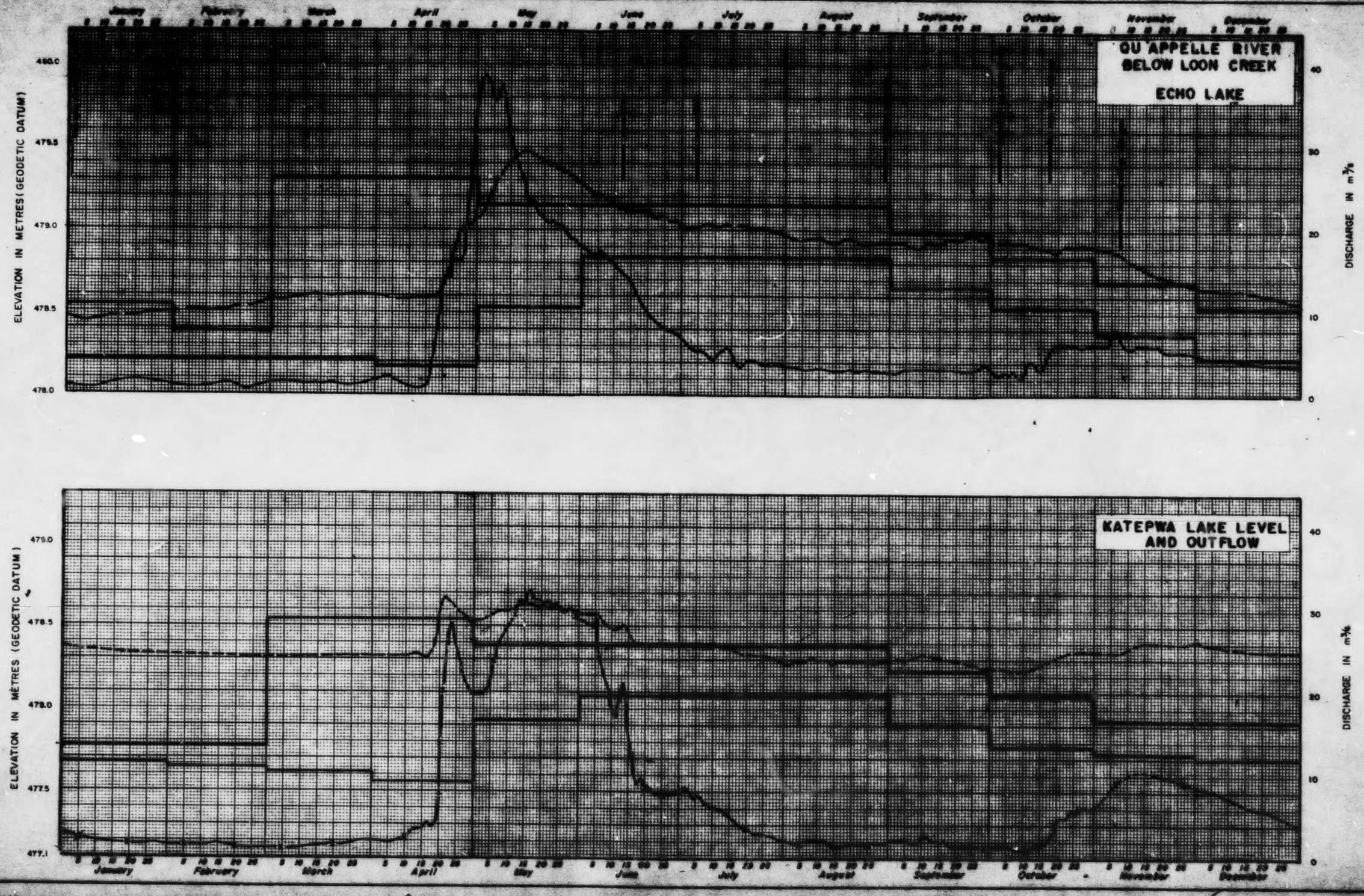
NOTE: PROVISIONAL DATA ONLY

Saskatchewan Environment
Hydrology Branch

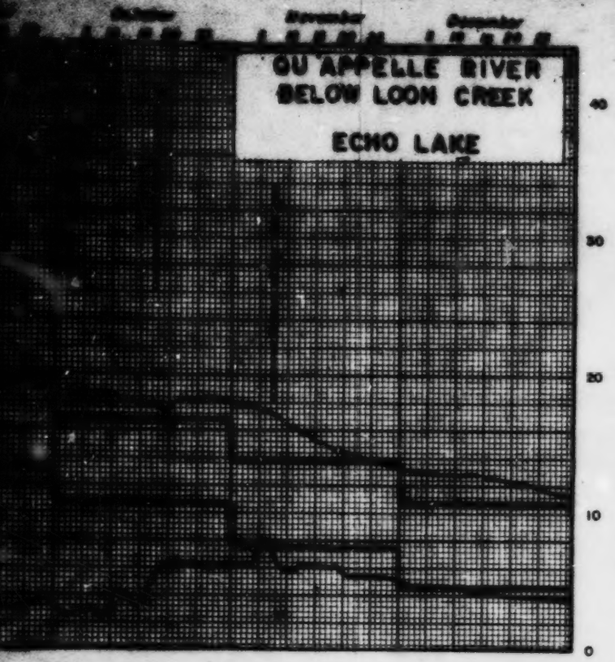
1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM

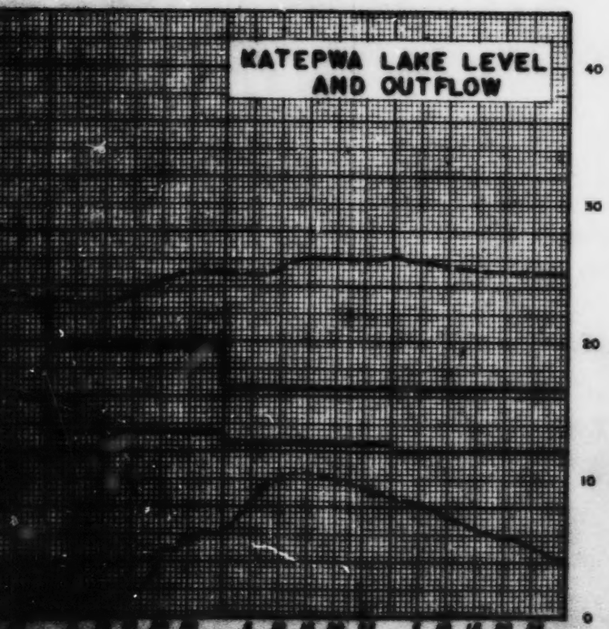
CRAVEN AREA

Drn. G.S.Y.	Date: JANUARY, 1981	Figure 4
Chd.	Plan No. NS-2-11(156)	


QU'APPELLE RIVER
BELOW LOON CREEK
ECHO LAKE
ELEVATION IN METRES (GEODETIC DATUM)
480.0
479.5
479.0
478.5
478.0
DISCHARGE IN m³/s
40
30
20
10
0
January
February
March
April
May
June
July
August
September
October
November
December
KATEPWA LAKE LEVEL
AND OUTFLOW
ELEVATION IN METRES (GEODETIC DATUM)
479.0
478.5
478.0
477.5
477.1
DISCHARGE IN m³/s
40
30
20
10
0

2-00-00-3





LEGEND

- QU'APPELLE RIVER BELOW LOON CREEK
- ECHO LAKE LEVEL
- KATEPWA LAKE LEVEL
- KATEPWA LAKE OUTFLOW
- MAXIMUM AND MINIMUM DESIRABLE LAKE LEVELS

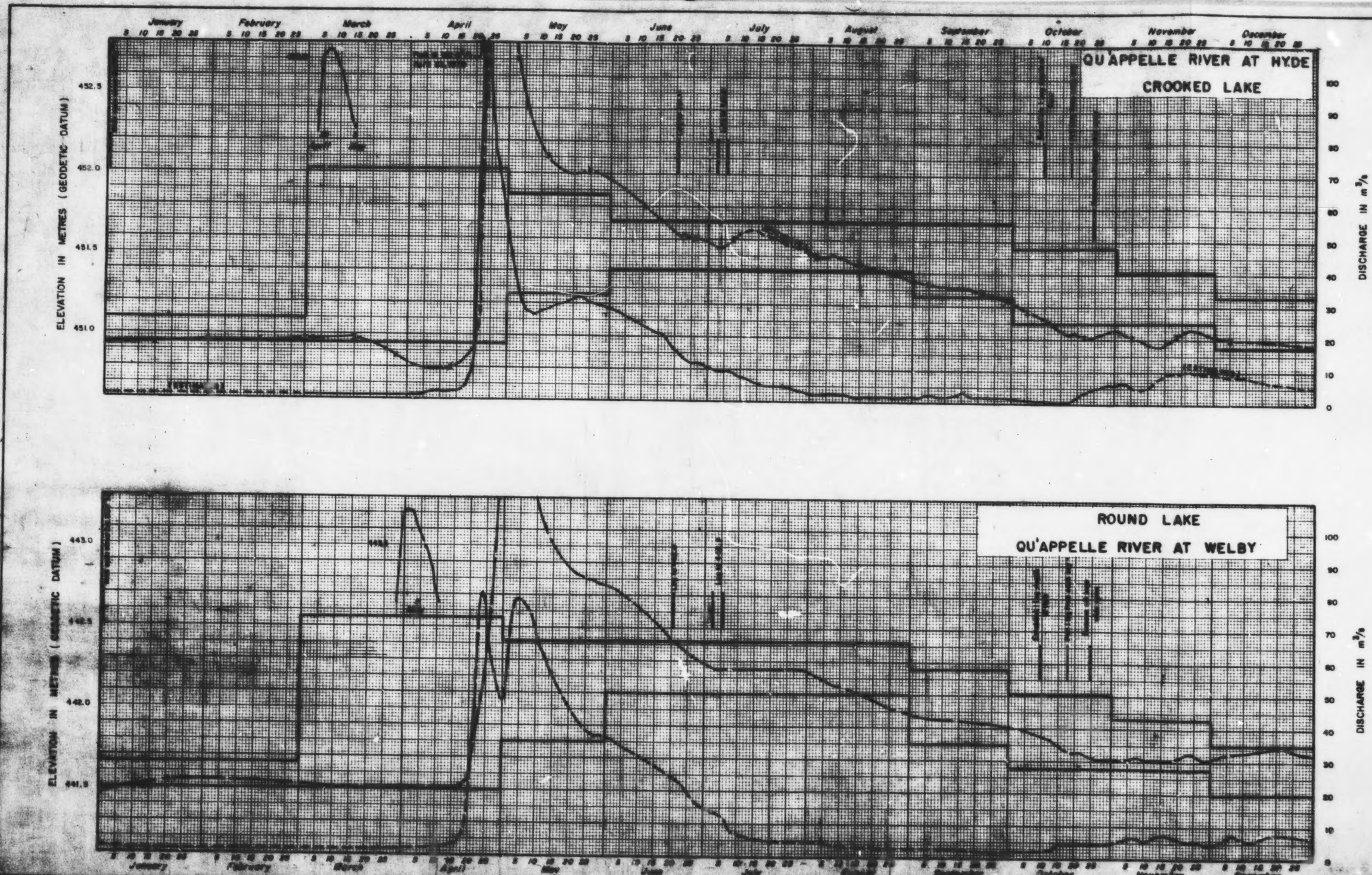
NOTE: PROVISIONAL DATA ONLY

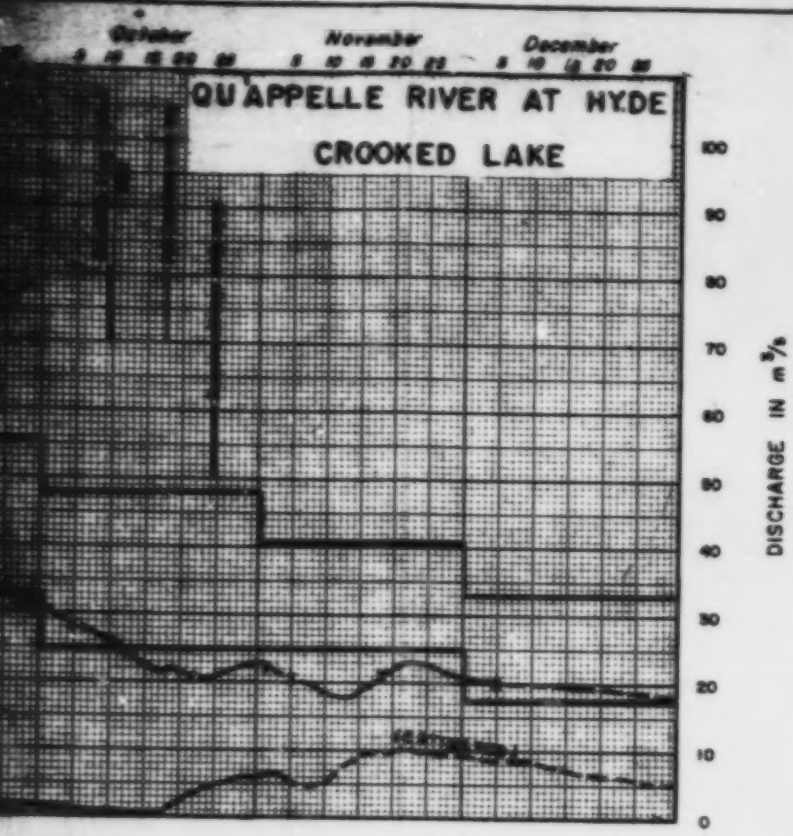
Saskatchewan Environment
Hydrology Branch

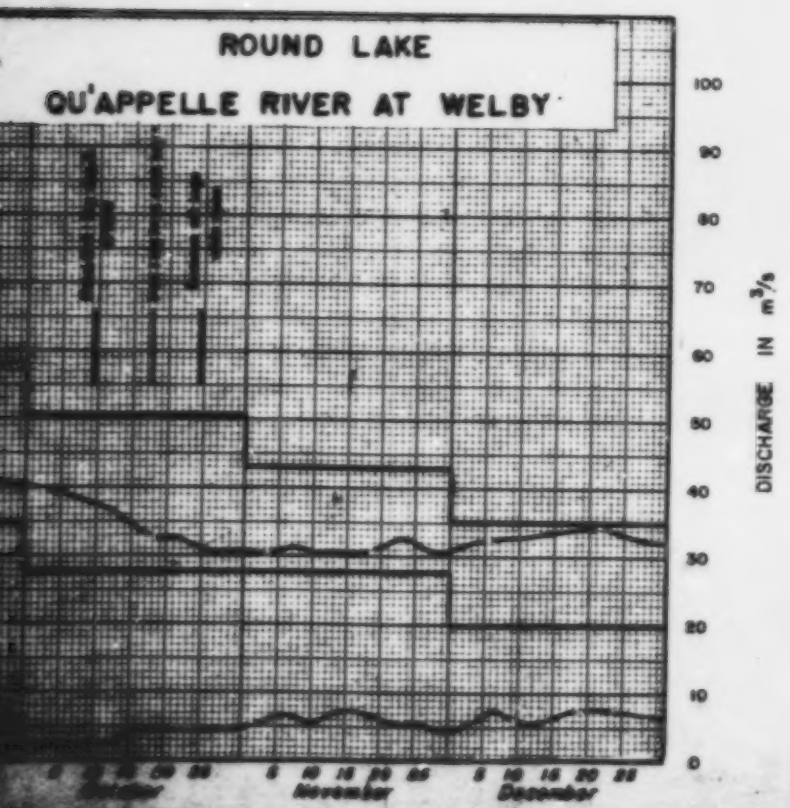
1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM

FISHING LAKES

Drn.: G.S.V.	Date: JANUARY, 1981	Figure 5
Ck'd.:	Plan No. HB-2-M(157)	


QU'APPELLE RIVER AT HYDE
CROOKED LAKE
ELEVATION IN METRES (GEODETIC DATUM)
DISCHARGE IN m³/s
January
February
March
April
May
June
July
August
September
October
November
December
452.5
452.0
451.5
451.0
100
90
80
70
60
50
40
30
20
10
0
ROUND LAKE
QU'APPELLE RIVER AT WELBY
443.0
442.5
442.0
441.5





LEGEND

- QU'APPELLE RIVER AT HYDE
- CROOKED LAKE LEVEL
- ROUND LAKE LEVEL
- QU'APPELLE RIVER AT WELBY
- MAXIMUM AND MINIMUM DESIRABLE LAKE LEVELS

NOTE: PROVISIONAL DATA ONLY

Saskatchewan Environment
Hydrology Branch

1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM

LOWER QU'APPELLE

Drn: G.S.Y.	Date: JANUARY, 1981	Figure 6
Ck'd.:	Plan No. HS-E-11(1861)	

APPENDIX A

QU'APPELLE OPERATION BOARD

APPENDIX A

QU'APPELLE OPERATION BOARD

The Qu'Appelle Operation Board, established in 1971 has the responsibility to develop operation procedures for the Qu'Appelle River System which will provide maximum overall benefit for all purposes including agriculture, recreation, municipal and industrial uses, pollution abatement and flood control. The members review and assess lake levels, river flows, streamflow forecasts and any problems in the basin related to operation so that operation plans can be established or modified as required. Once recommendations are put forward by the Board, the Hydrology Branch of the Saskatchewan Environment oversees the various operations.

The Board has representation from:

Saskatchewan Environment (Chairman)
Saskatchewan Agriculture
Saskatchewan Tourism and Renewable Resources
Prairie Farm Rehabilitation Administration
Qu'Appelle Management Board's Public Advisory Council
(2 members)

The members are appointed to the Board by the Minister of the Environment on the advice of the respective agencies. The current membership is listed in Table A-1.

The Board meets at various times throughout the year; in late winter prior to spring runoff, in late spring following spring

runoff, and in late summer, to review past and present flows and operations, discuss and assess streamflow forecasts and set an operation plan for the pending period. Other meetings are called as necessitated by current conditions. A variety of matters dealing with requests for water, problems encountered from past operation, construction of fish and wildlife projects, conveyance improvements and any topic requiring the approval of the Board are also discussed at these meetings.

A more detailed account of discussion can be obtained from the minutes of these meetings.

Table A-1

1979 QU'APPELLE OPERATION BOARD

Agency	Member	Alternate
Saskatchewan Environment	D.L. MacLeod Director Hydrology Branch (Chairman)	S.R. Blackwell Chief Water Management Service
Saskatchewan Agriculture	D.O. Coghlan Chief Engineer Conservation and Land Improvement Branch	A. Veroba Conservation and Land Improvement Branch
Saskatchewan Tourism and Renewable Resources	L.G. Lensen Director Regional Services	H.G. Ritchie Supervisor Engineering Services Division
Federal Government Department of Regional Economic Expansion (PFRA)	A.F. Lukey Regional Engineer	R.G. McIntyre Regional Operations Engineer
Qu'Appelle Operation Advisory Committee	K. Rippert G. Hoffman	

APPENDIX B

CONTROL STRUCTURES ON THE QU'APPELLE RIVER SYSTEM

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I INTRODUCTION

Prior to the arrival of settlers, the Indians and fur traders used the Qu'Appelle River as a means of travel and transportation. With the settlers came the railway and interest in the Qu'Appelle River changed from a means of travel to a source of water supply for domestic, municipal, industrial, irrigation and recreation needs.

During the late 1800s, numerous small temporary earth fill dams at various locations were periodically constructed to backflood irrigate haylands, maintain a domestic water supply and maintain lake levels for the fishing industry. Many of these structures built by local inhabitants were inadequately designed, hurriedly constructed and poorly maintained. They would occasionally wash out and would have to be replaced. The intention of the Government of the day was to gradually replace these small temporary structures with larger more permanent ones at more suitable locations. However, as a result of a return to more favourable moisture conditions on the prairies at the turn of the century, this program of large dam construction never materialized.

The drought of the 1930s once again emphasized the need for a better system of increasing and maintaining water supply in the Qu'Appelle Valley. The Prairie Farm Rehabilitation Administration (PFRA), established in 1935, was given the task of developing an adequate permanent water supply system in the valley. To this end, a series of control structures were built in the early 1940s at the

outlets of Buffalo Pound, Last Mountain, Echo, Katepwa, Crooked and Round Lakes to increase the storage capacity of these lakes and through controlled releases benefit agriculture for stockwatering and irrigation uses throughout the valley. Also, controlled lake levels greatly enhanced the recreational value of the lakes. Control structures were also built just below the Moose Jaw River-Qu'Appelle River confluence and at Craven to aid in controlling flows along the Qu'Appelle River. A small check structure near Fairy Hill was built to aid in the backflooding irrigation of haylands in the area. A small check structure below Eyebrow lake provided a means of diverting water to a waterfowl project on the lake. Construction of the Qu'Appelle River Dam allowed for the diversion of Lake Diefenbaker water to the Qu'Appelle River. At various times and at numerous places between Buffalo Pound and Pasqua Lakes small temporary earth fill dams have been constructed to aid in backflood irrigation of haylands.

In general, most major control structure operations are carried out by PFRA. The Buffalo Pound Lake control is operated by Saskatchewan Agriculture, Conservation and Land Improvement Branch while Saskatchewan Tourism and Renewable Resources operates the check structure at Eyebrow Lake. Minor operations at the Valeport control and screw gate adjustments at the Craven control are carried out by Saskatchewan Environment. All operations are co-ordinated by Saskatchewan Environment within policy guidelines established by the Qu'Appelle Operation Board.

II STRUCTURE CHARACTERISTICS

A. QU'APPELLE RIVER DAM

As part of the development of the South Saskatchewan River Project a dam was required to prevent Lake Diefenbaker from overflowing into the Qu'Appelle river system. Therefore between 1963 and 1967 an earth dam was constructed in 36-23-4-3, the drainage divide between the South Saskatchewan and Qu'Appelle Rivers. Because the South Saskatchewan River was to be used as an additional source of water for the Qu'Appelle River system a gated concrete conduit was built within the Qu'Appelle River Dam to convey water from Lake Diefenbaker to the Qu'Appelle system (Figure B-1).

Although the gated conduit was designed to release 70 m^3/s to meet possible future domestic, industrial and irrigation demands along the Qu'Appelle, releases to the upper Qu'Appelle have been limited to 11 m^3/s, the downstream channel capacity. Weed growth during the summer months can reduce this capacity by as much as 50 to 75 per cent.

Releases through the Qu'Appelle River Dam are set by adjusting the control gates using theoretical rating curves which relate flows to lake levels and gate openings.

B. EYEBROW LAKE CONTROL STRUCTURE

During the late 1950s, as part of improving river capacity to convey Lake Diefenbaker water to Buffalo Pound Lake and also because of a saline problem with water passing through Eyebrow Lake, an artificial conveyance channel was built around Eyebrow Lake. Beginning in the SW 1/4 28-23-2-3, the river was diverted along the north side of the valley and rejoins the original Qu'Appelle River channel in the NE 1/4 36-22-2-3.

Saskatchewan Tourism and Renewable Resources and Ducks Unlimited developed and operate the Nisku waterfowl project at Eyebrow Lake. The lake and surrounding marshland have been dyked into cells as shown on Figure B-2, and gated culverts control the flow of water from the Qu'Appelle River into the various compartments in the lake. A small timber stop-log control structure in the river channel just below the lake (NE 36-22-2-3) makes it possible during periods of low flow to raise upstream river levels to divert water into the various cells in the lake (Figure B-3). Water is not released from Eyebrow Lake due to its poor quality.

C. BUFFALO POUND LAKE CONTROL STRUCTURE

Proposals for damming the outlet of Buffalo Pound Lake to create a reservoir originated as early as 1895. Major

benefits ranging from flood and pollution control to irrigation and recreation enhancement were cited as justification for this project.

Construction of a dyke and control structure at the east end of the lake and a diversion dam just below the junction of Moose Jaw River and Qu'Appelle River began in 1939 and was completed in 1940. The main concrete structure in the NE 1/4 35-18-25-2 with overflow radial gates is used to control the level and outflow of Buffalo Pound Lake. The second concrete dam in the NW 1/4 31-18-24-2 is used to divert Moose Jaw River flows into Buffalo Pound Lake.

Studies in 1949 indicated that, with water diverted from the South Saskatchewan River, Buffalo Pound Lake was the most reliable source of municipal water for Regina and Moose Jaw. To provide extra lake storage for this increased municipal demand an extension was added to the top of the gates of the main control. Further extension to the gates was made in 1955 and 1960 when it was suggested that increased storage in Buffalo Pound Lake would aid in flood control in the Qu'Appelle.

Because the diversion dam below Moose Jaw river was creating undesirable backwater problems and it was no longer necessary to divert Moose Jaw River water into Buffalo Pound Lake,

because Lake Diefenbaker provided a more reliable and better quality source of water, it became expendible. In the fall of 1969, the gates, breast wall and centre pier were removed from the diversion dam to restore natural flow conditions.

In 1972, the Buffalo Pound Lake control structure was modified again. The radial gates were removed and replaced with timber stop-logs.

In 1969, the ownership of the Buffalo Pound control structure was transferred to the Province of Saskatchewan with Saskatchewan Agriculture doing the actual operation and maintenance under Saskatchewan Environment's guidance.

Saskatchewan Agriculture modified the structure in the spring of 1978 by installing a screw gated CMP beside the right bay (see Figure B-4). This riparian outlet gate will increase the flexibility and ease of operation in making low flow releases. It will also be used in conjunction with stop-log removal to make releases in all ranges.

Operations involve the addition or removal of logs depending on desired result; i.e. raise or lower lake level or provide a controlled downstream release. Major releases usually associated with lowering lake levels or passing excess inflows are controlled by removing logs and allowing flow over top of

the logs. Flow over the logs is affected by wind and lake levels and requires numerous adjustments to maintain a steady flow. Also, fine adjustments to specific releases are difficult because of the size of the logs. Lower releases to meet downstream demands are controlled by using the gated CMP riparian outlet below lake level. Flows through this gate are not affected as much by wind and lake levels and require fewer adjustments to maintain a steady release. Also, finer adjustments and specific releases are possible by varying the size of the gate opening. For certain releases a combination of log and gate operations will be required. Release adjustments are based on theoretical settings that relate flows to lake levels, top log elevation and/or size of orifice opening.

D. VALEPORT CONTROL STRUCTURE

Following construction of the Craven Dam in 1903 and improvements to Last Mountain Creek for the diversion of water from the Qu'Appelle River to Last Mountain Lake to raise lake levels to aid navigation on the lake, much of the land between the Qu'Appelle River and the lake was flooded. To reclaim some of this hayland, and to assist in holding water in the lake, the Valeport dyke was constructed in 1939 across the NW 1/4 28-20-21-2 (Figure B-5). A small concrete lift gate control structure was built across Last Mountain Creek. In

1941, two overflow timber lift gate control structures were added to the dyke, one 1,000 feet southwest and one 1,500 feet northeast of the creek. In 1949, to increase the diversion capacity into Last Mountain Lake, a canal was constructed connecting the Qu'appelle River in SE 1/4 14-20-21-2 and Last Mountain Creek NE 1/4 15-20-21-2 and the control structure through the Valeport dyke was removed.

In 1957-58, following damage done by the floods of 1955 and 1956, the Valeport dyke was reconstructed and the control structure was replaced with a timber stop-log structure (Figure B-6). The southwest overflow structure was replaced by a small concrete drop inlet structure with screw gated cmp's culverts. The northeast overflow structure gradually deteriorated, finally washed out in the spring of 1976 and was replaced by an earth plug.

The present stop-log control structure is used in conjunction with the Craven Dam to control the flow into and out of Last Mountain Lake and to maintain water levels in Last Mountain Creek and Qu'Appelle River upstream of the Craven Dam for use by area market gardeners. Flows are controlled by adjusting the logs based on flows in the Qu'Appelle River, the levels of Last Mountain Lake and the desired effect; i.e., direction of flow, raise or lower lake levels, maintain water levels in the area. The overflow structures are used in times of extreme

floods to pass the high flows thus reducing possible damage to the dyke.

E. CRAVEN CONTROL STRUCTURE

The Craven Dam was originally built in 1903 to raise Last Mountain Lake levels to aid navigation. Damaged by the flood of 1906, the dam was rebuilt in 1909. The dam again collapsed in 1923 and was rebuilt in 1925.

In the 1930s, long after diversion of water for navigational purposes on Last Mountain Lake ceased to be required, the diversion rights and the Craven Dam were transferred to the PFRA for agricultural purposes to be operated in conjunction with other water control projects along the Qu'Appelle.

In 1943, the timber structure was replaced by the present concrete dam with a combination of timber stop-log and lift gate (Figure B-7) controls.

This control structure located on the Qu'Appelle River in SW 1/4 24-20-20-2, a short distance downstream of Last Mountain Creek, is used in conjunction with the Valeport structure to control the flow into or out of Last Mountain Lake and to maintain desirable river levels upstream of the Craven control for irrigation pumping by market gardeners in the Craven area.

Regulation of flows is controlled by adjusting the number of logs and/or adjusting the size of the gate opening, depending on desired effect; i.e., direction of flow, maintenance of levels, and control of downstream flows. Gate control provides a more specific and stable release than log control as it is less sensitive to changes in fluctuating upstream water levels caused by rain, wind effects on Last Mountain Lake and upstream releases.

F. ECHO LAKE CONTROL STRUCTURE

As early as 1888 a dam was constructed below Echo Lake. Built by the Fisheries Department of the federal government, it is assumed the main reason for construction was to safeguard the fishing industry by helping to maintain lake levels. This dam was repaired or replaced on various occasions during the 1890s and early 1900s.

Investigations by the PFRA during the late 1930s indicated that water storage facilities on the Fishing Lakes would supply sufficient water to irrigate lands between Katepwa and Crooked Lakes. In addition to serving a valuable agricultural purpose, restoring lake levels would greatly enhance the recreational value of the lakes. Regulation of stream flow from projects at Buffalo Pound and Last Mountain Lakes as well as runoff from local tributaries could supply water to this project.

The present concrete structure with timber stop-log and one lift gate control was built in 1942-43. Located in NW 1/4 7-21-13-2 on the Qu'Appelle River, a short distance downstream of Echo Lake, this dam controls the level of both Pasqua and Echo Lakes.

This dam is operated to maintain lake levels desirable for recreation purposes while maintaining downstream flows. Therefore, logs are set in the control to the desired elevation and excess waters are allowed to flow over top of the logs. Specific releases are not usually made from Echo Lake, however, releases required to maintain live downstream flows or to lower lake levels are made by adjusting the number of logs and allowing water to flow over the remaining logs until the desired result is achieved.

G. KATEPWA LAKE CONTROL STRUCTURE

Originally built in 1888 by the Fisheries Department, the first dam was intended to maintain lake levels to safeguard the fishing industry. This dam in NW 1/4 27-19-12-2 was a fixed crest timber weir with one stop-log controlled bay and a fish ladder. Subjected to numerous washouts and repairs, this dam was replaced in 1906 by a larger dam slightly upstream of the old dam and at its present location. This dam was repaired many times due to washouts and acts of vandalism. In

the fall of 1937, it was completely removed and replaced by a new larger fixed crest timber weir. In 1958, following another cycle of washouts and repairs, PFRA designed and constructed the present larger fixed crest timber overflow weir with a screw gated riparian outlet in the left abutment (Figure B-9).

During the period October 1978 and August 1979 a new concrete control (combination of radial and screw gates) and channel was constructed approximately 100 m south west of the existing timber structure (Figure B-10).

The Katepwa Lake control is used to maintain lake levels on Mission and Katepwa Lakes. Water automatically spills over the weir and radial gates as levels rise above the crest elevation (full supply level of the lake) at a rate proportional to the height above the weir. Releases, when lake levels are below the crest elevation, are made through the small slide gate and/or radial gates depending on purpose i.e. to maintain live downstream flows for stockwatering purposes, or to drawdown lake levels to provide more storage. Under high flow conditions, the structure affects water levels on all four of the Fishing Lakes.

H. CROOKED LAKE CONTROL STRUCTURE

In 1932, various cottage owners petitioned the government for permission to construct a small structure at the outlet of

Crooked Lake to raise lake levels to improve water quality and enhance recreation facilities. A stone weir was built at this site, but by 1939 the weir had fallen into a state of disrepair so that it no longer was doing the job it was intended for and once again, cottagers petitioned for a more permanent dam under government control.

Studies by PFRA concluded that a control to increase the storage capacity of Crooked Lake would serve a valuable agricultural purpose for stockwatering and irrigation in the valley between Crooked and Round Lakes, while also improving recreation possibilities.

In 1941, a concrete structure with timber stop-log control was constructed at the outlet of Crooked Lake in SW 1/4 8-19A-5-2 to raise lake levels providing storage for irrigation purposes (Figure B-11).

This dam is operated to maintain lake levels desirable for recreation purposes while maintaining downstream flows. Therefore, logs are set at the desired elevation and excess waters are allowed to flow over top of the logs. Specific releases are not usually made from Crooked Lake, however, releases required to maintain downstream flows or to lower lake levels, are made by adjusting the number and elevation of logs, and allowing water to flow over the remaining logs, until the desired result is achieved. On occasions when a specific release is required, flow may be controlled by

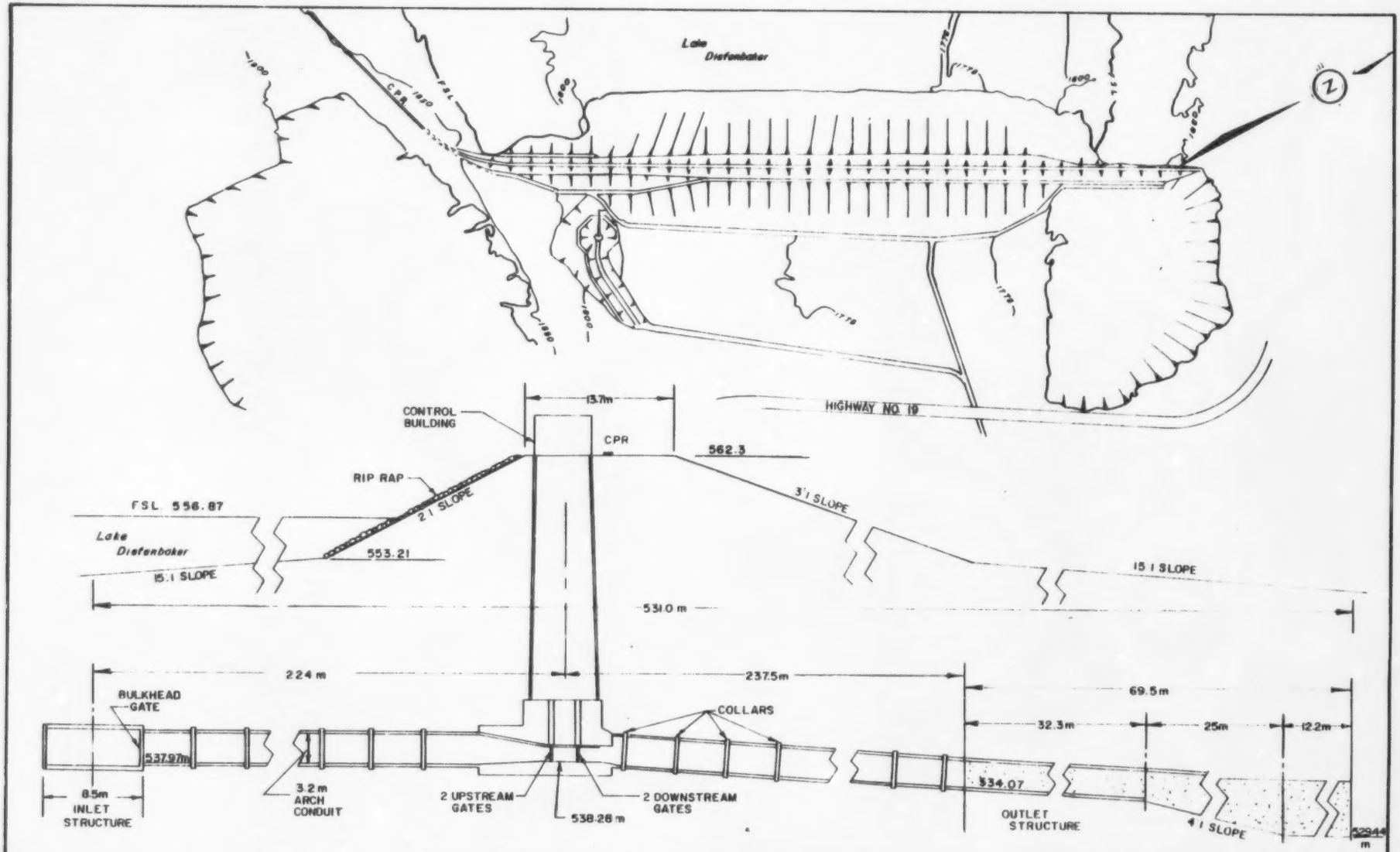
inserting wedges between the logs which maintains a steady flow less affected by lake levels or wind action.

I. ROUND LAKE CONTROL STRUCTURE

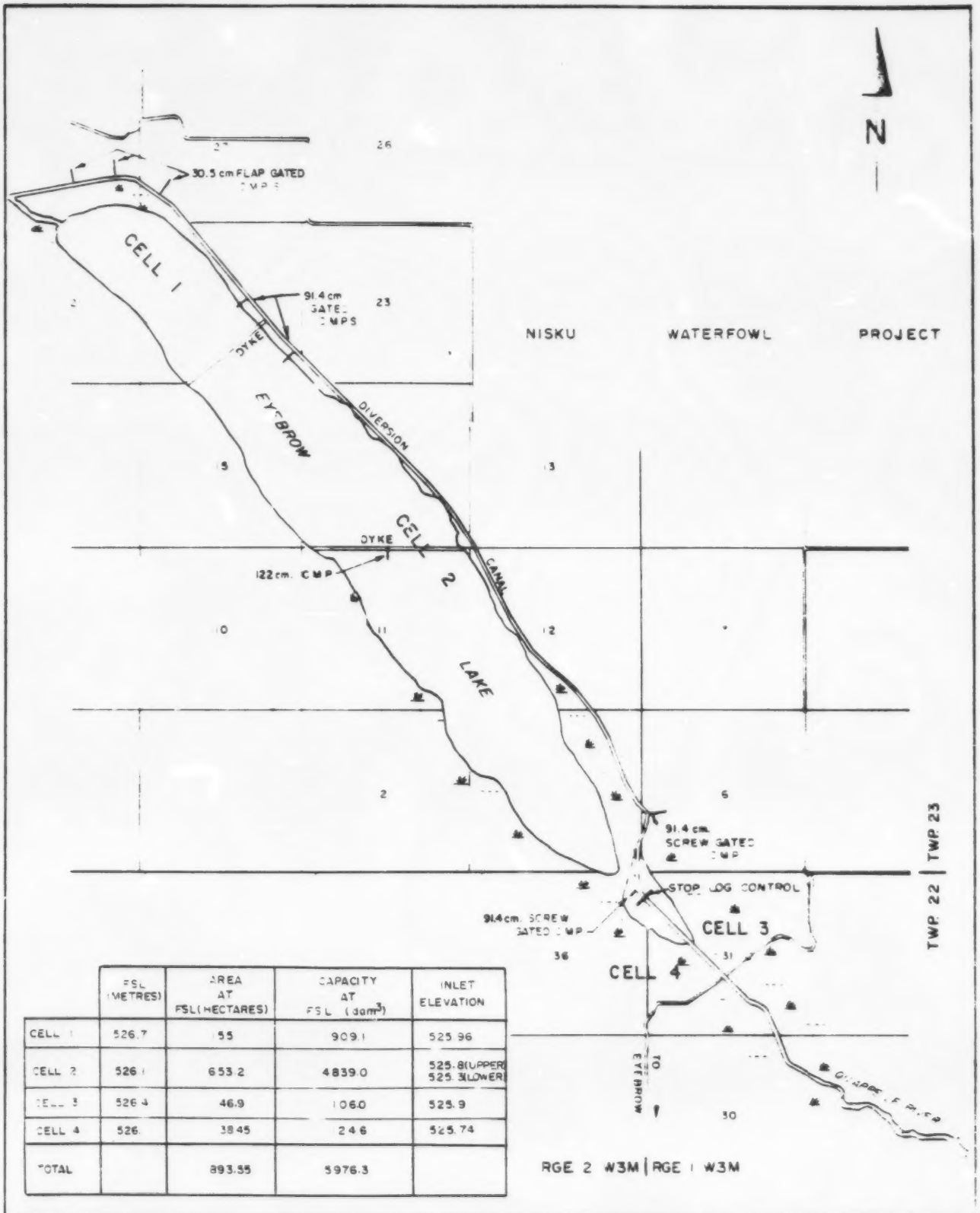
Proposals to increase the storage capacity of Round Lake, by building a dam below the lake, were studied and deemed beneficial for irrigation uses at the same time as the Crooked Lake study.

In 1941, a concrete structure with timber stop-log control was constructed at the outlet of Round Lake in NE 1/4 14-18-3-2 to raise lake levels providing storage for irrigation purposes (Figure B-12).

This dam is operated to maintain lake levels desirable for recreation purposes while maintaining downstream flows. Therefore, logs are set at the desired elevation and excess waters are allowed to flow over top of the logs. Specific releases are not usually made from Round Lake, however, releases required to maintain downstream flows or to lower lake levels are made by adjusting the number and elevation of logs, and allowing water to flow over the remaining logs until the desired result is achieved. On occasion when a specific release is required, flows may be controlled by inserting wedges between the logs which maintains a steady flow less affected by lake levels or wind action.

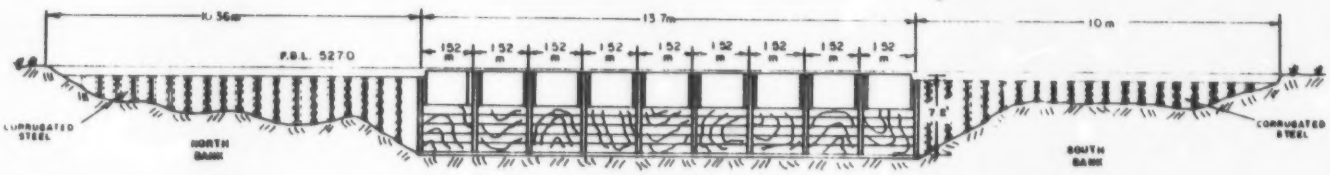


Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM	Figure
Drn GSY	Date FEBRUARY 17, 1981	DETAIL PLAN OF QU'APPELLE RIVER DAM & OUTLET WORKS	B-1
Ck'd	PlanNo H5-2-11(159)		



	FSL (METRES)	AREA AT FSL (HECTARES)	CAPACITY AT FSL (dam^3)	INLET ELEVATION
CELL 1	526.7	155	909.1	525.96
CELL 2	526.1	653.2	4839.0	525.8 (UPPER) 525.3 (LOWER)
CELL 3	526.4	46.9	106.0	525.9
CELL 4	526.	38.45	24.6	525.74
TOTAL		893.55	5976.3	

Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM EYEBROW LAKE NISKU WATERFOWL PROJECT	FIGURE B-2
Drn	Date		
Ck'd	Plan No H5-2-11(160)		

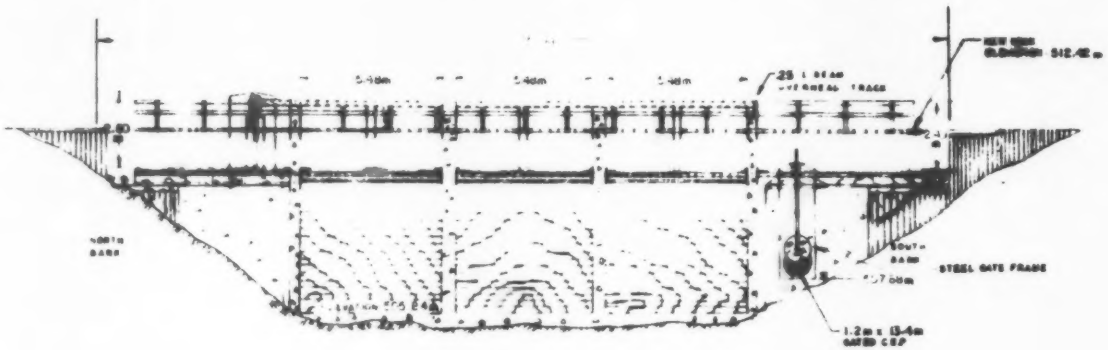


UPSTREAM ELEVATION

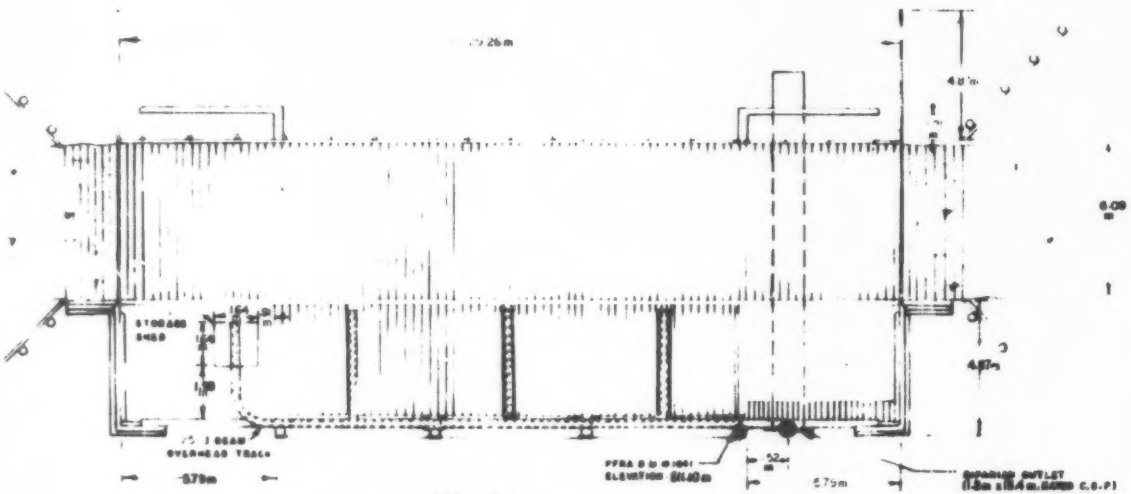
TOP VIEW

SCALE: 1/16"=1'

Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM DETAIL PLAN OF EYEBROW LAKE CONTROL STRUCTURE	FIGURE B-3
Drn.	Date		
Ck'd	Plan No H5-2-11(161)		

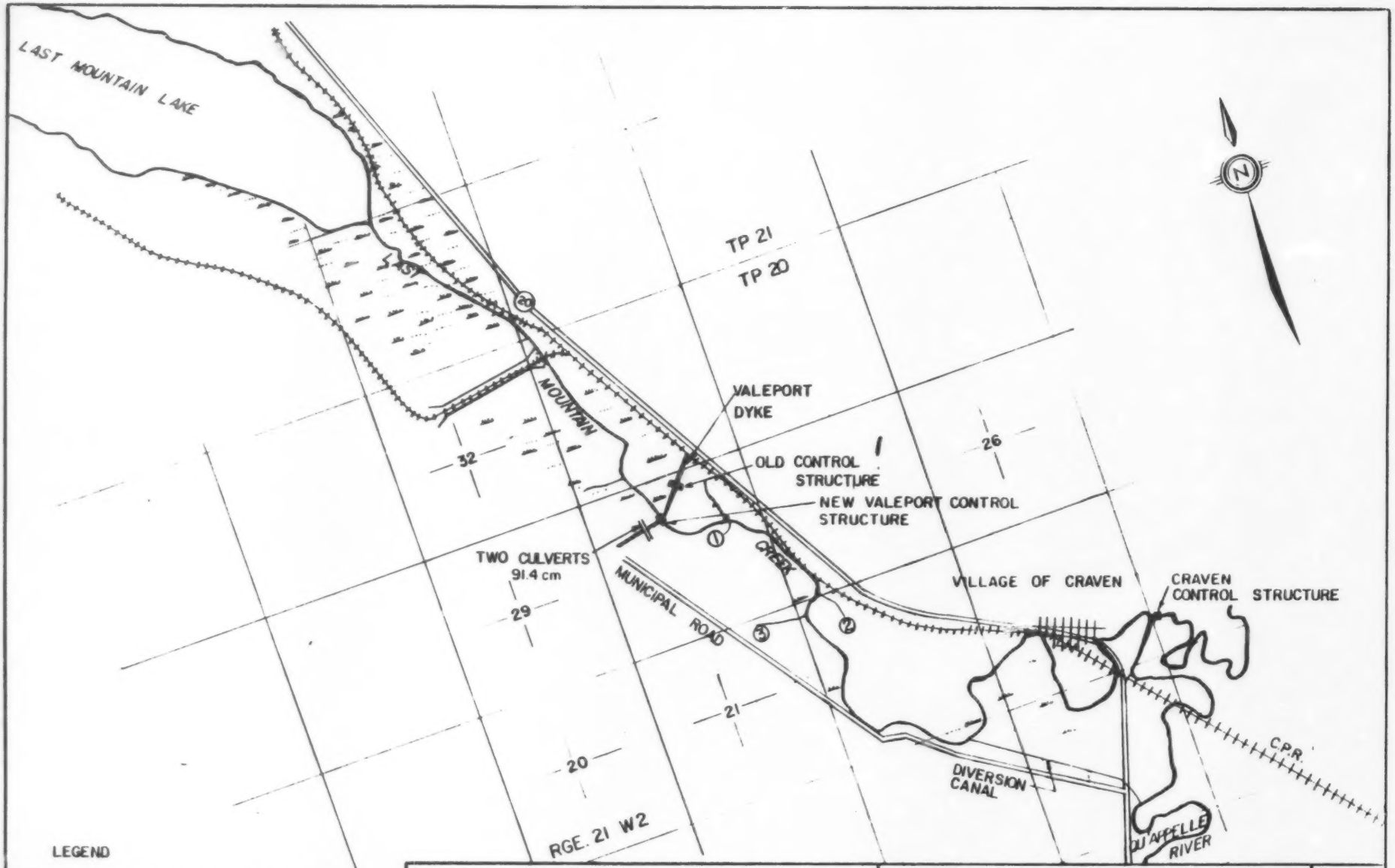


UPSTREAM ELEVATION



TOP VIEW

Saskatchewan Environment Hydrology Branch	1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM **DETAIL PLAN** OF **BUFFALO POUND LAKE** **CONTROL STRUCTURE**	FIGURE B-4
Drn | Date Chk | Plan No H5-2-11(162)		



LEGEND

① DRAINAGE DITCH (1 SCREW GATE)
② DRAINAGE DITCH (2 SCREW GATES)
③ DRAINAGE DITCH (3 SCREW GATES)

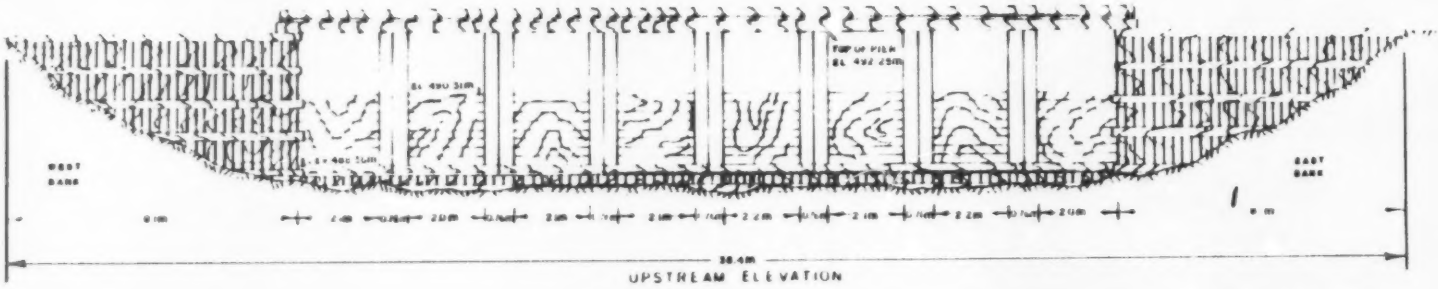
Saskatchewan Environment
Hydrology Branch

Drn	Date
Ck'd	Plan No H5-2-11(163)

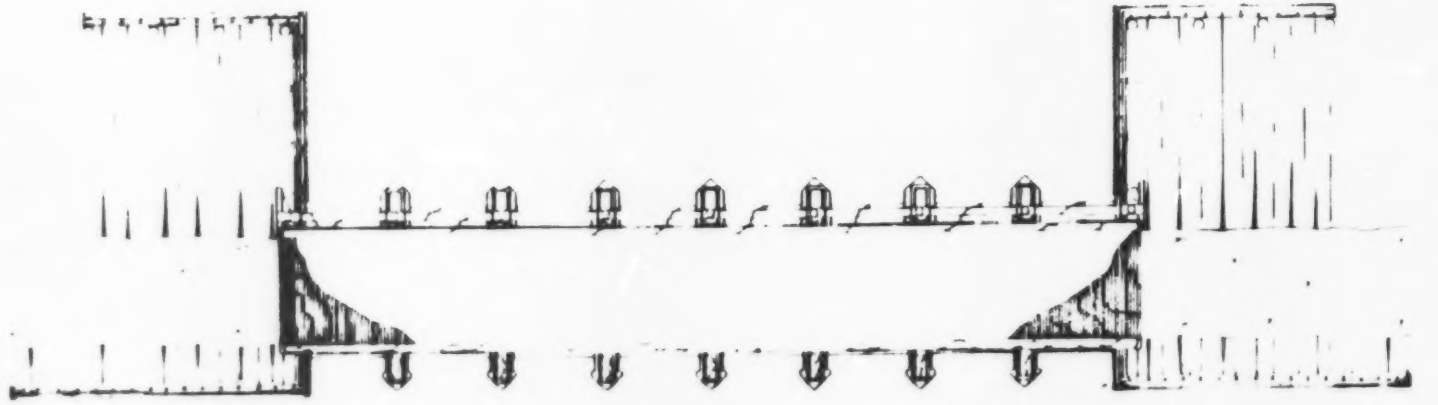
1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM

KEY MAP OF CRAVEN AREA

FIGURE B-5

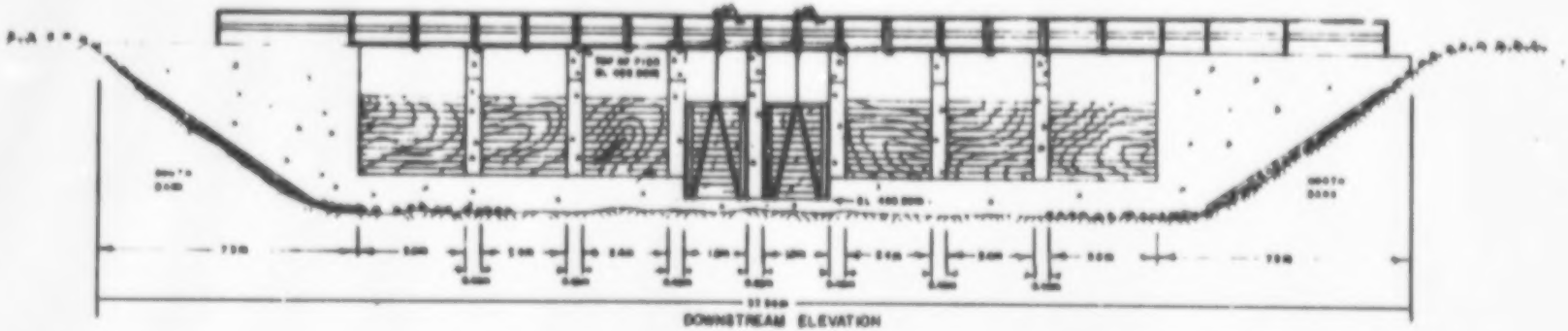


UPSTREAM ELEVATION

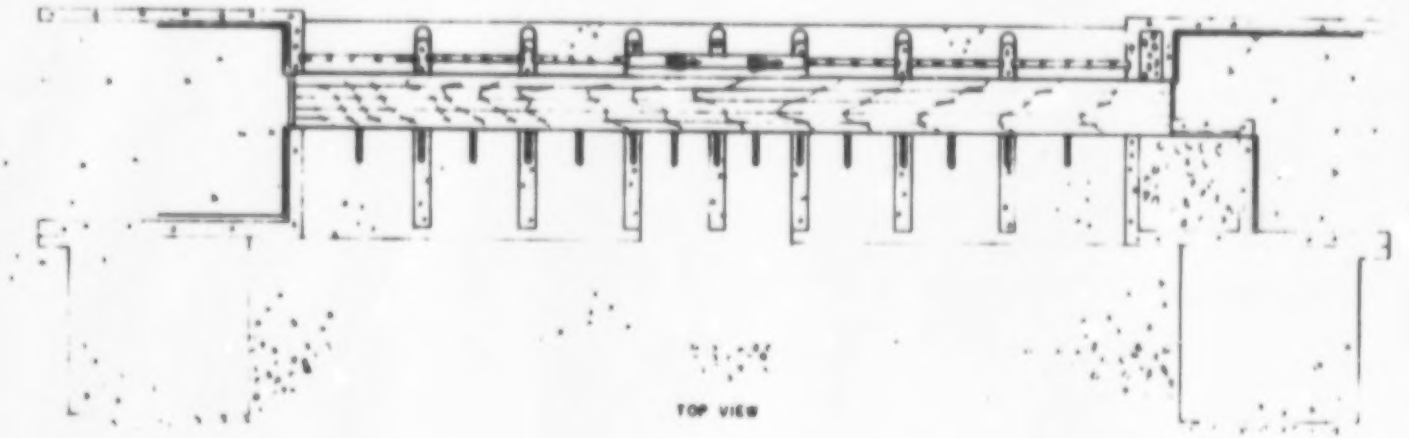


TOP VIEW

Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM DETAIL PLAN OF VALE PORT CONTROL STRUCTURE	FIGURE B-6
Drn	Date		
Ck'd	Plan No. H5-2-11(164)		

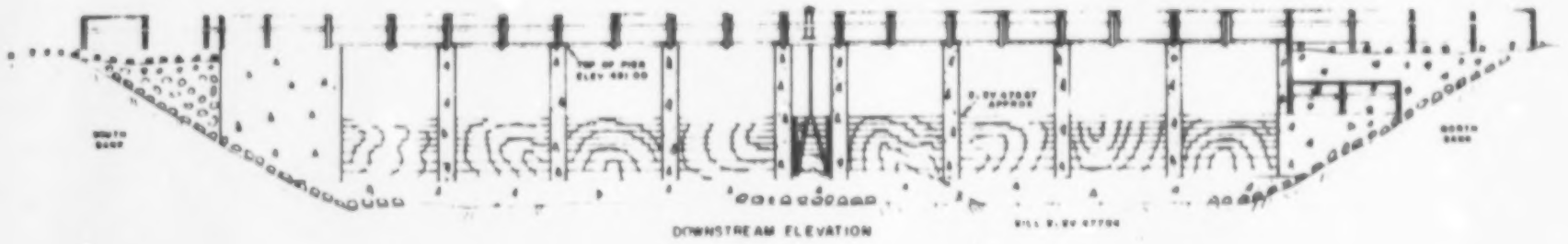


DOWNSTREAM ELEVATION

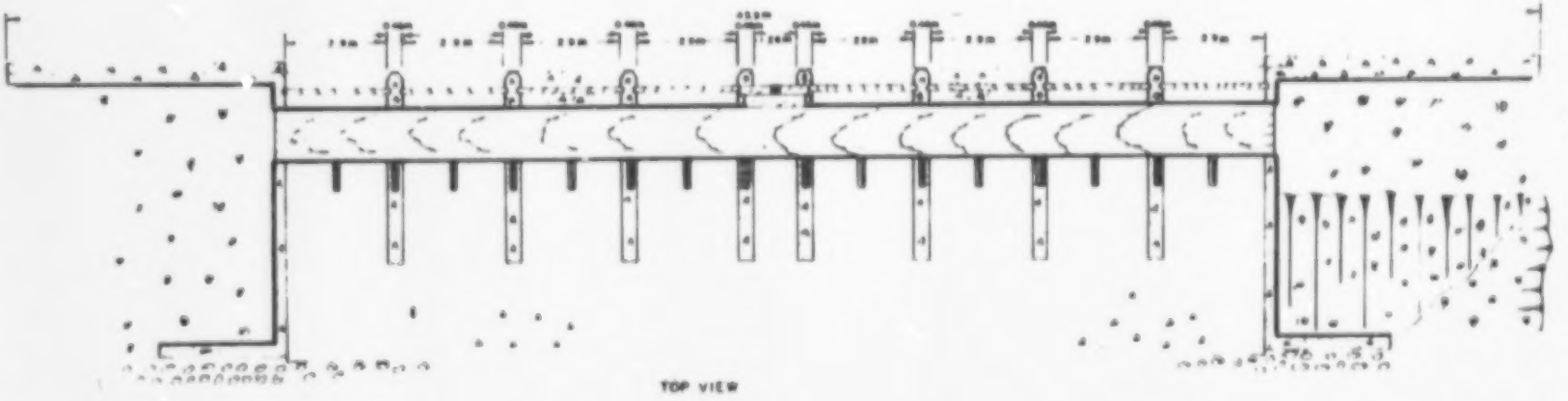


TOP VIEW

Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM **DETAIL PLAN** OF **CRAVEN** **CONTROL STRUCTURE**	FIGURE B-7
Drn.	Date		
Ch'd	Plan No. HS-2-11 (166)		



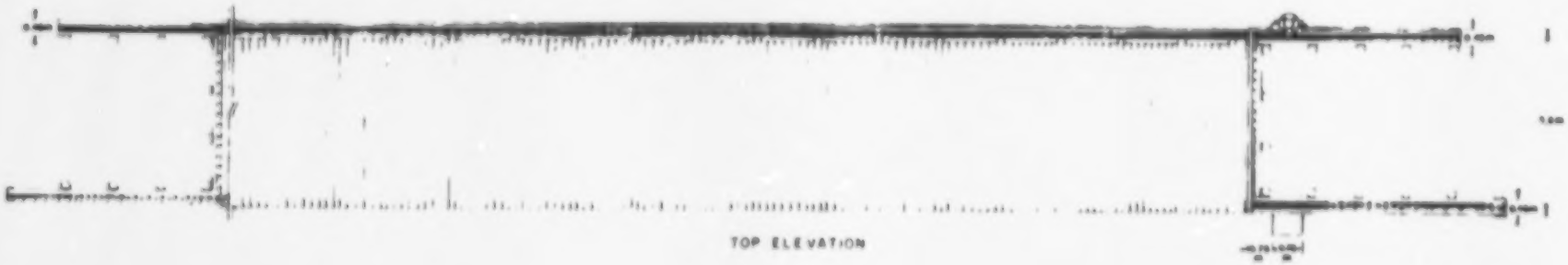
DOWNSTREAM ELEVATION



TOP VIEW

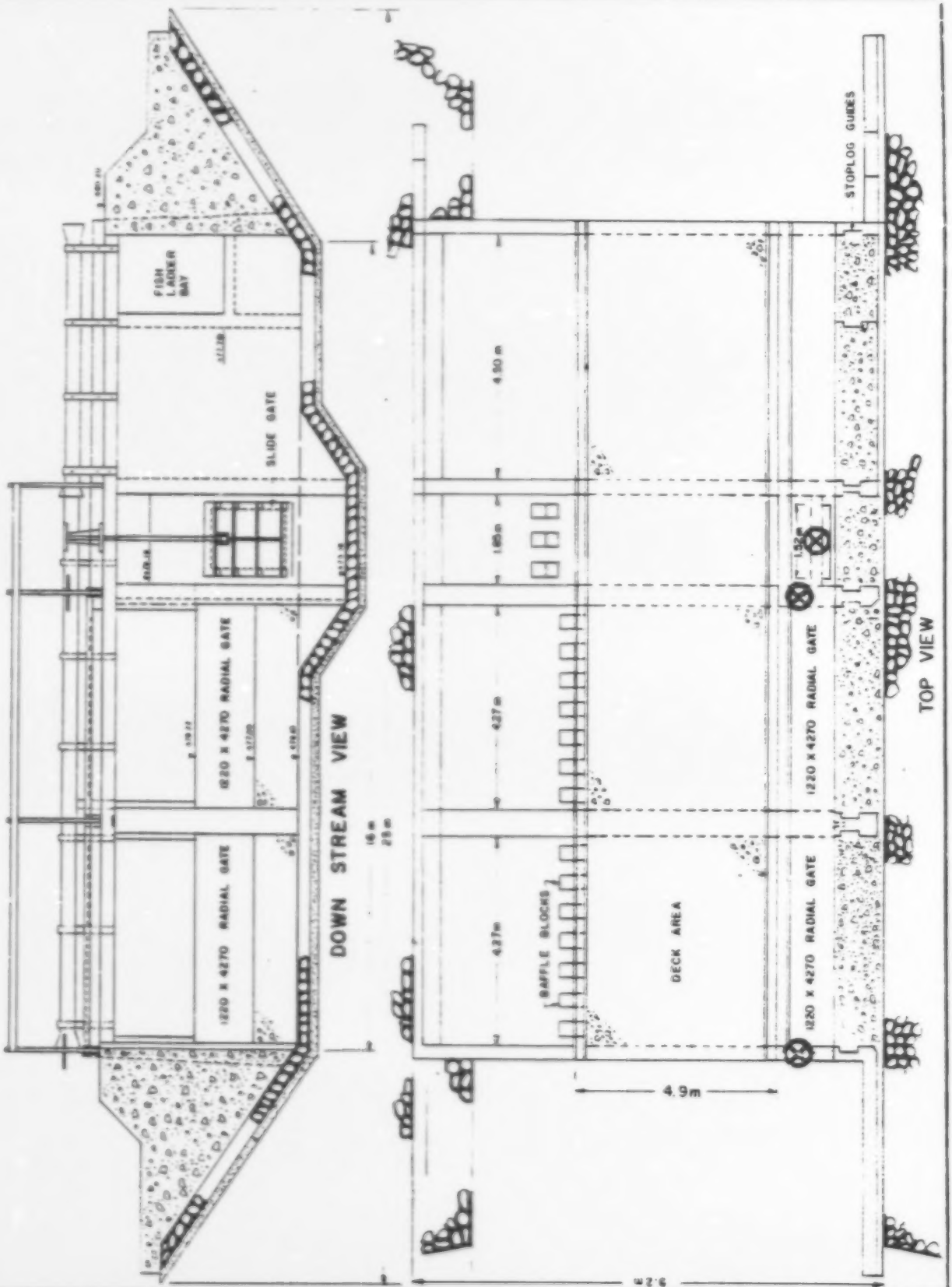
Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM DETAIL PLAN OF ECHO LAKE CONTROL STRUCTURE	FIGURE B-8
Drn.	Date		
Ckd.	Plan No. H5-2-11(166)		

UPSTREAM ELEVATION

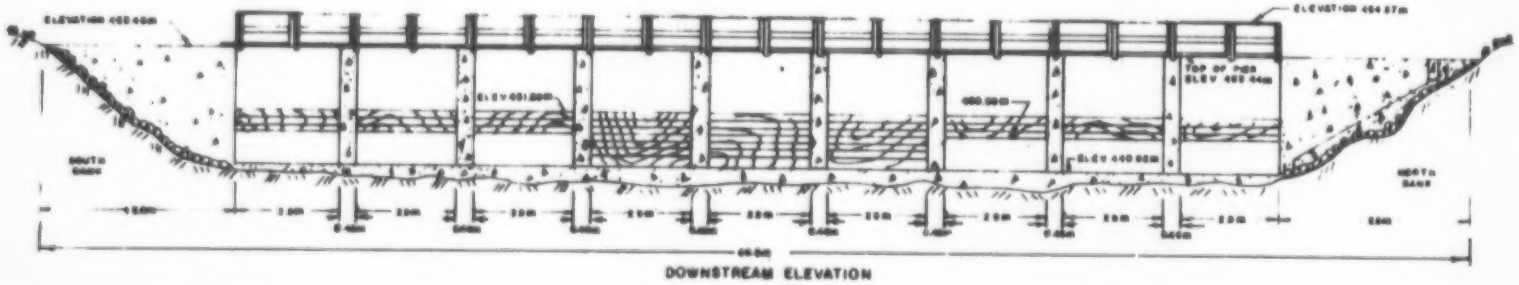


TOP ELEVATION

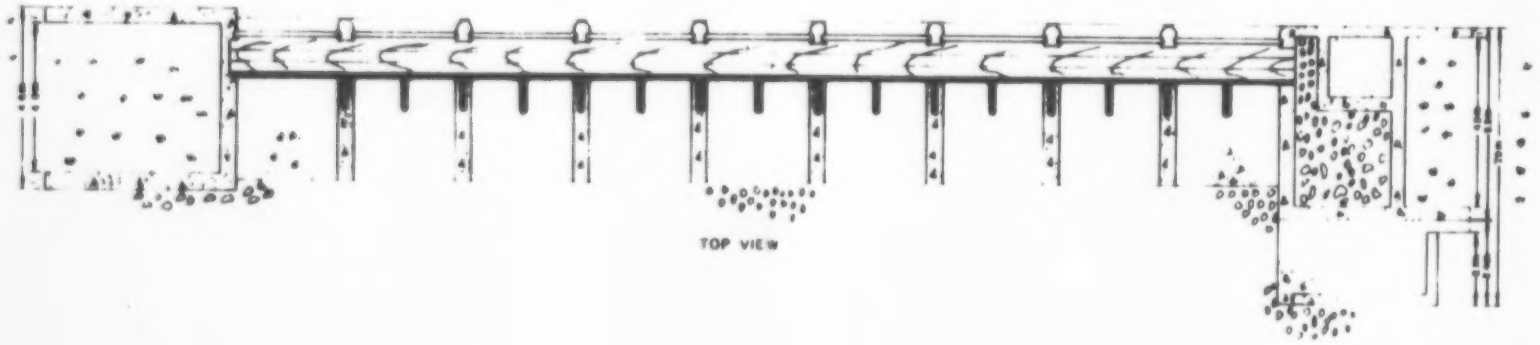
Saskatchewan Environment Hydrology Branch /		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM **DETAIL PLAN** OF **KATEPWA LAKE** **FIXED CREST WEIR**	FIGURE B-9
Drn.	Date		
Ch'd.	Plan No H5-2-III(167)		



Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM DETAIL PLAN OF KATEPWA LAKE CONTROL STRUCTURE	Figure B-10
Drn. J.B.	Date JAN/81		
Ck'd.	Plan No HS-2-1K(168)		

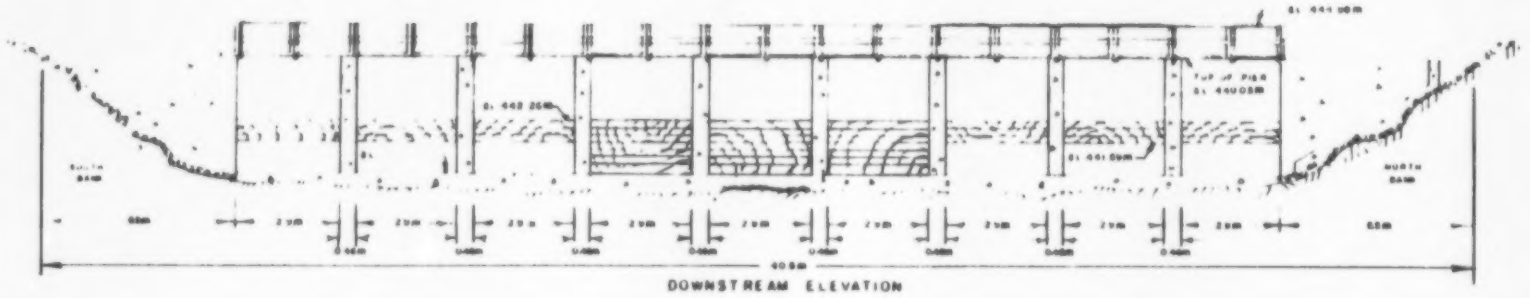


DOWNSTREAM ELEVATION

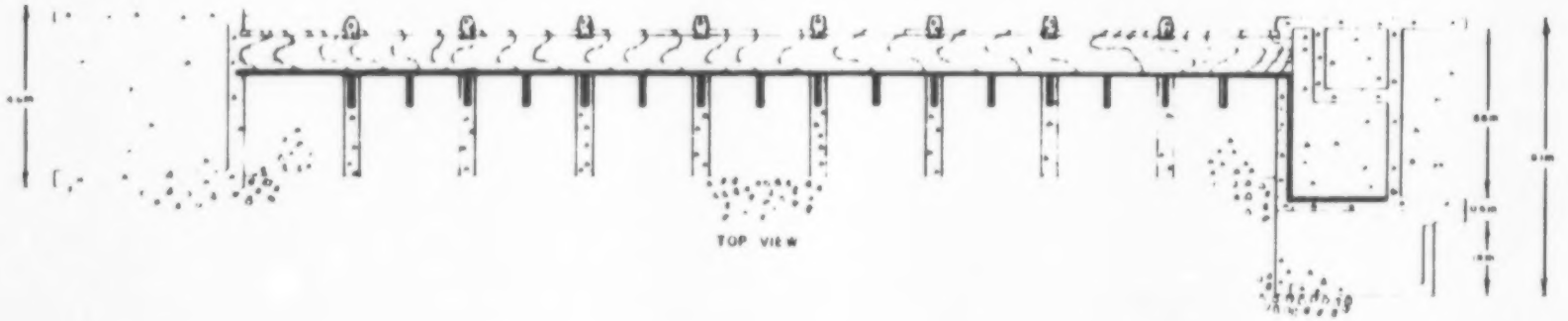


TOP VIEW

Saskatchewan Environment Hydrology Branch		1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM DETAIL PLAN OF CROOKED LAKE CONTROL STRUCTURE	FIGURE B-11
Drn.	Date:		
Ck'd	Plan No H5-2-11(J69)		



DOWNSTREAM ELEVATION



TOP VIEW

Saskatchewan Environment	1979 OPERATION OF THE QU'APPELLE RIVER SYSTEM	FIGURE
Hydrology Branch	DETAIL PLAN OF ROUND LAKE CONTROL STRUCTURE	B - 12
Drn. / Date:		
Ck'd. / Plan No H5-2-11(170)		

POOR

QUALITY

ORIGINAL